THE WONDER BOOK OF AIRCRAFT

THOMAS-MAYBANK
PETROL
PETROL

[illegible] 1919

Mr. Ian Hartley. (LATE OF.)
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Lancs.

Mr. Ian Hartley.
40 Baxtergate.
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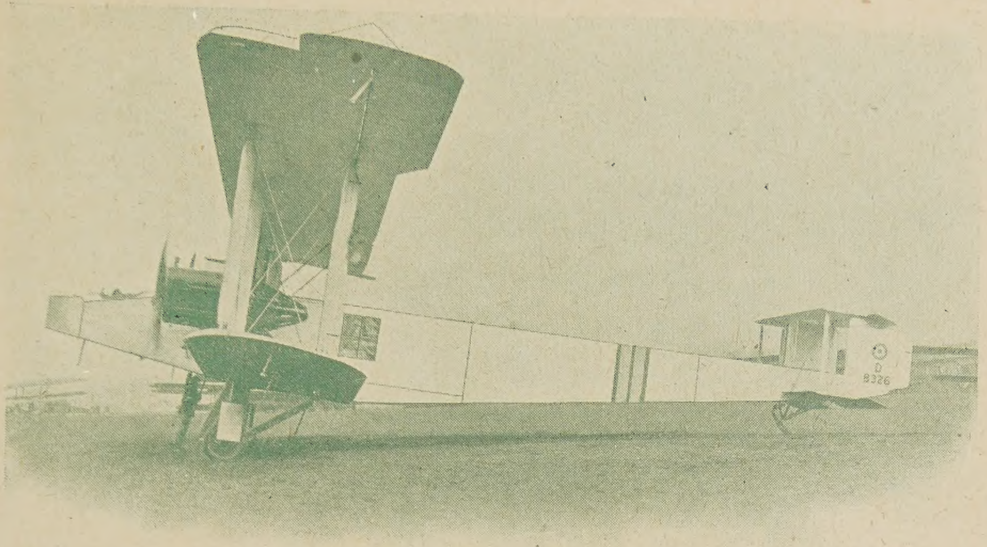
Yorks.



THE WONDER
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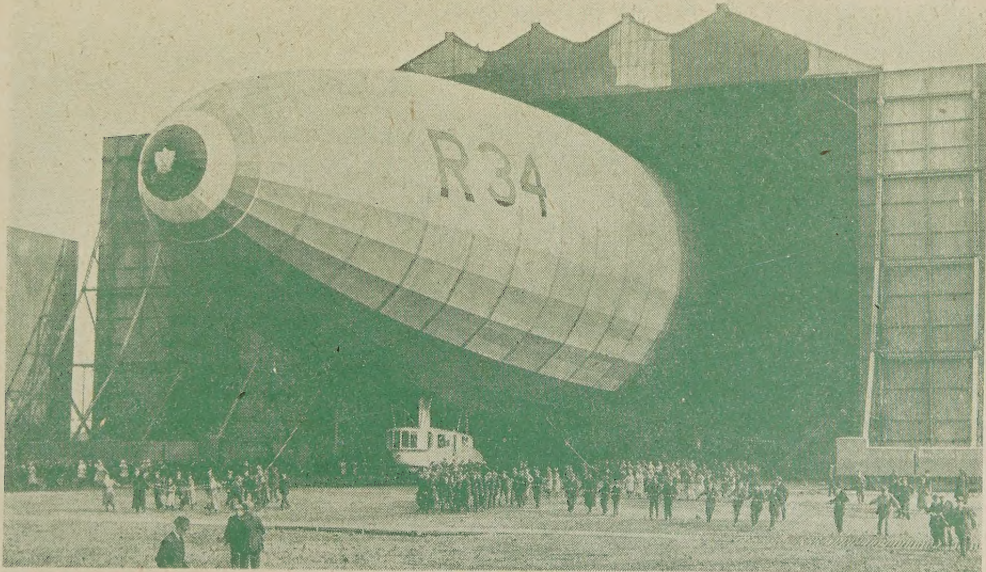

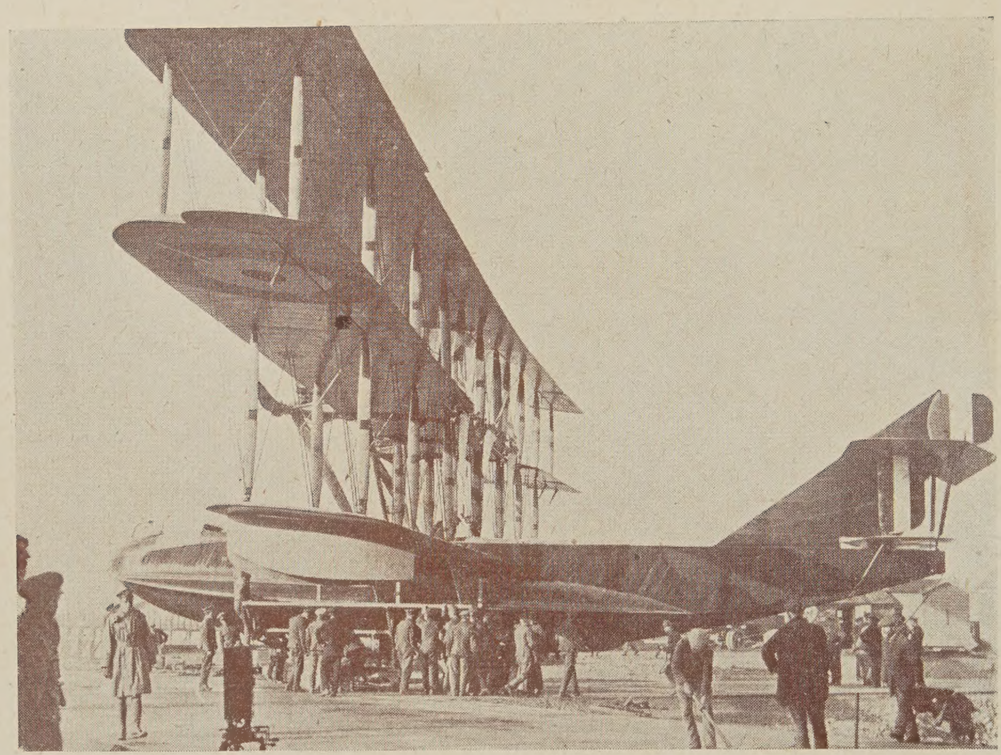

[*Royal Air Force Official.*

A BRITISH TRIPLANE FLYING BOAT.

This monster has a wing span of 123 feet, a length of 60 feet, and a height of nearly 30 feet. Total weight, 23,400 lbs.

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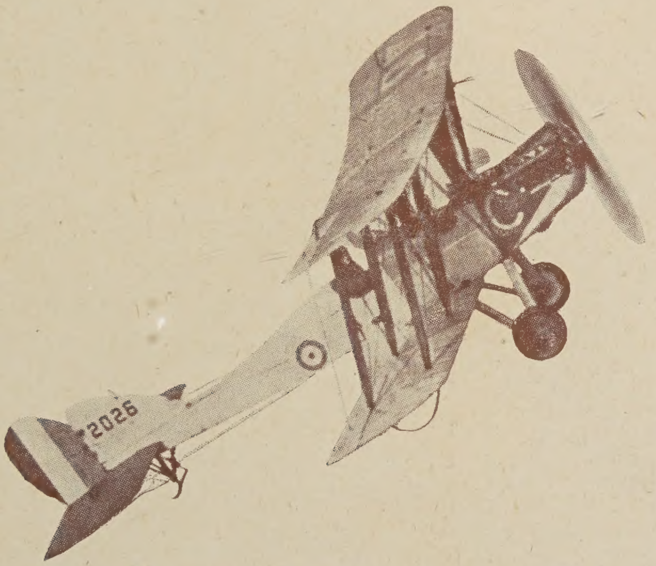
A GIANT OF THE AIR.
A HANDLEY PAGE FOUR-ENGINED BIPLANE.

[*Frontispiece.*

THE WONDER
Book of Aircraft

FOR BOYS AND GIRLS

> "*War has been the making of aviation ; let us hope that aviation will be the destruction of war.*"—
> MAJOR-GENERAL W. S. BRANCKER, K.C.B., C.M.G., D.S.O.



TWELVE COLOURED PLATES AND OVER TWO HUNDRED PICTURES

EDITED BY HARRY GOLDING

SECOND EDITION.

WARD, LOCK & CO., LIMITED
LONDON, MELBOURNE AND TORONTO
1919

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THE HERO.

An old boy of a public school, now a pilot, visiting his former chums by aeroplane.

COLOURED PLATES.

A Sopwith Triplane Scout. From the original painting by *Geoffrey Watson* . . . . *Front Cover.*
A Giant of the Air: A Handley Page Four-Engined Biplane. From the original painting by *Geoffrey Watson* . . . . . . *Frontispiece.*
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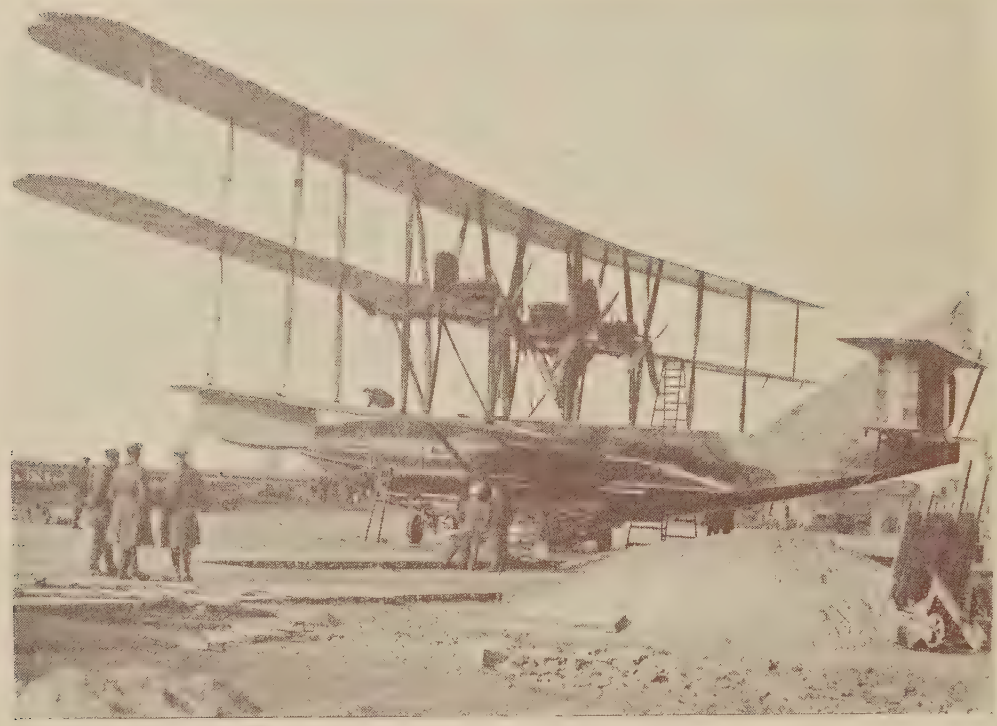
The End-papers by *Thomas Maybank.*



[Royal Air Force Official.

ANOTHER VIEW OF THE GREAT BRITISH TRIPLANE FLYING BOAT.

It will be seen that there are five Rolls-Royce engines, four arranged in tandem sets, and one single "pusher."

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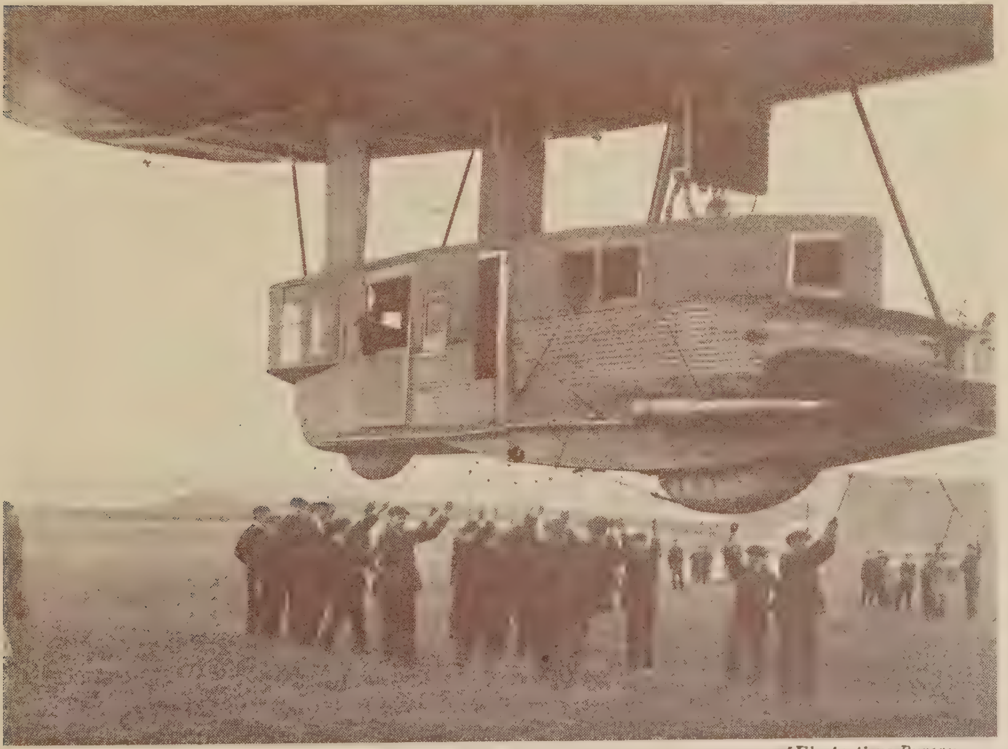

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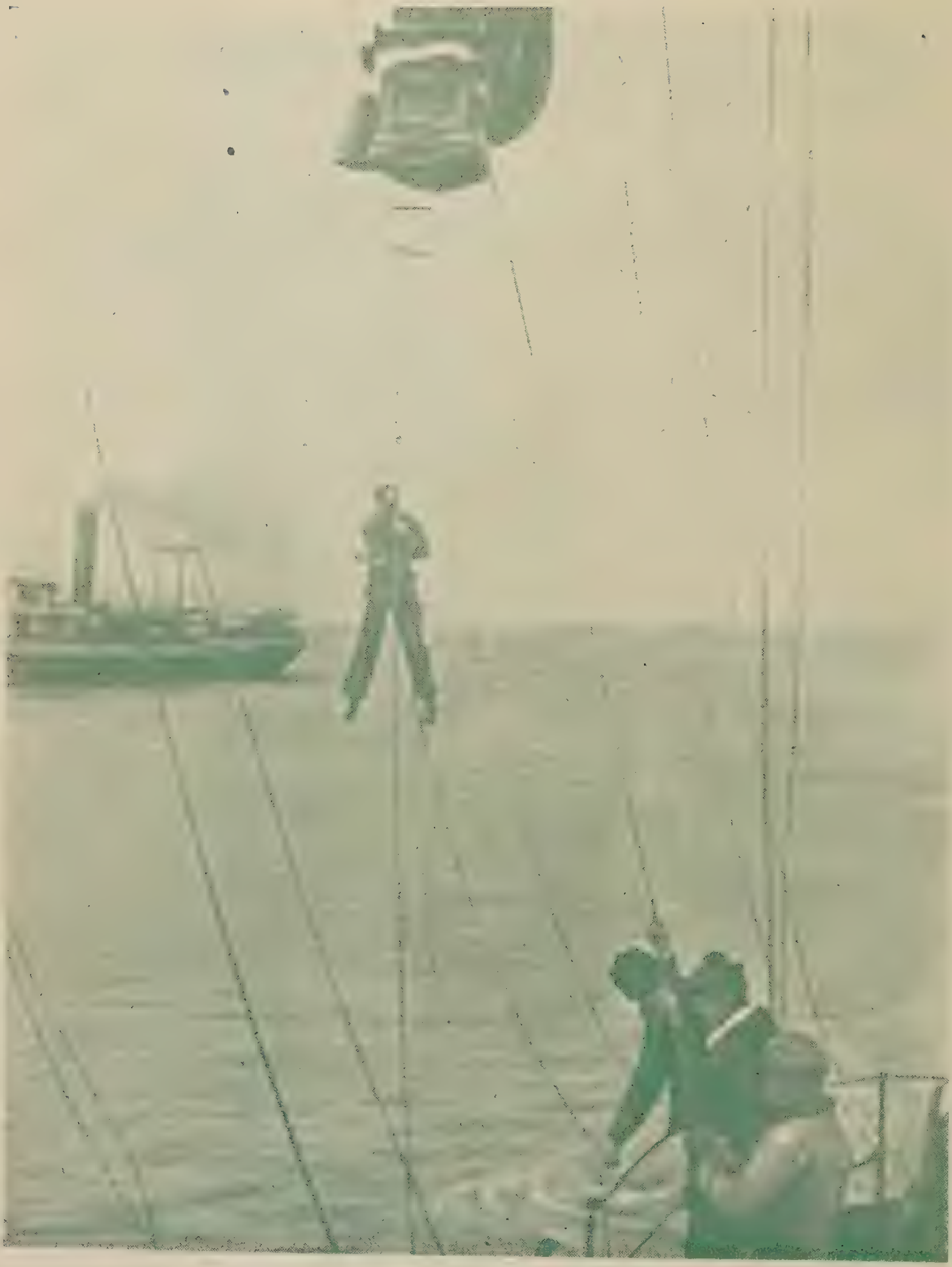
THE FRONT GONDOLA OF THE BRITISH AIRSHIP R 34, WHICH MADE THE HISTORIC RETURN JOURNEY ACROSS THE ATLANTIC IN JULY, 1919.



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AN OBSERVER DESCENDING FROM THE BASKET OF A KITE BALLOON TO THE DECK OF A TRAWLER.

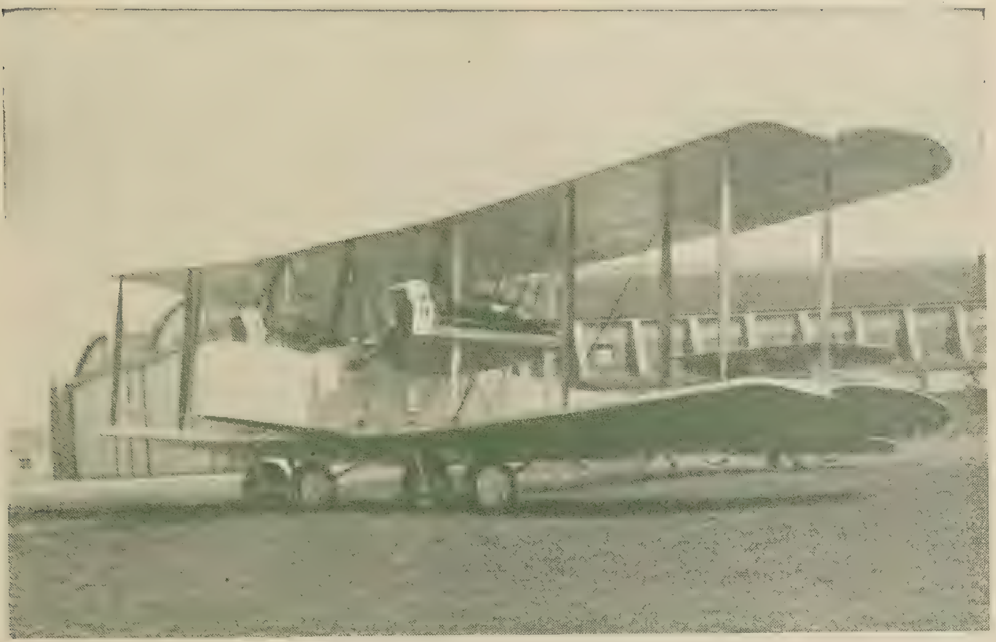


Photo by] [*Captain Sir J. Alcock, D.S.C.*

THE FIRST DIRECT NON-STOP ATLANTIC FLIGHT.

The Vickers-Vimy-Rolls machine in which Captain J. Alcock and Lieut. Arthur Whitten Brown (both afterwards knighted) made the first direct flight across the Atlantic from St. John's, Newfoundland, to Clifden, Galway, on June 14th–15th, 1919. The distance of 1,950 miles was covered in 16 hours 12 minutes, the average speed being about 120 miles per hour.

The Conquest of the Air

The Problem of the Ages and How it was Solved

PEOPLE frequently remark that "flying is only a few years old." So far as successful flight is concerned the statement is true. But the history of flying and of attempts at flying is as old as civilization itself. Probably the story began almost with the first man, who, looking up at the birds and seeing their easy and apparently effortless movements in the air, wished he could imitate them. There are authentic accounts of attempts at flight in the history of every nation, and behind history are many legends of men who flew. Egypt, Assyria, India and Greece furnish the legends, which almost certainly had some foundation in attempted flights. It is more than probable that the myth of Dædalus and Icarus you read in your school books is based on a truth, and is the distorted story of some man who tried to imitate the birds and paid for the attempt with his life.

Coming to historical times, a long list could be given of men who studied flight and attempted to fly; and, without doubt, they attempted the solution of the greatest problem with which humanity has ever been confronted. For flight involves the conquest of an element concerning which man knows very little even now—he knew practically nothing at all about it until the first balloon ascended, about a century and a quarter ago.

To realize what these early attempts at flight really meant try to imagine yourself as having lived all your life on a small island, none of the inhabitants of which have ever been in the water. Supposing you, knowing nothing of the qualities of water, were the first on that island to enter the water and attempt to swim. You would know nothing of the currents which might drag you away from shore to a death by drowning; you would not know whether the water would support your weight, nor how to make it support that weight; you would know nothing of the movements of swimming, nor even whether it was necessary to make any movement. In being the first to enter the water, you would plunge into a new world, a world of which nobody knew anything at all; and, no matter what preparation you made, or what aids you considered necessary, you would require courage of the highest order before venturing.

So with early attempts at flight. These men of old lived in the island which is the world, surrounded by the vast ocean of the air. They knew nothing of what was required to support them in the air, except that they had an idea that something after the form of a bird's wing was necessary, but to this day science has not been able to imitate the wing of a bird in such a form that it will serve for flight with the weight of a man. They tried, time after time, these early men, to devise substitutes for the wings of birds; incurring general ridicule from their fellows, and in some cases actual persecution, in days when any attempt at progress was considered due to the influence of the Evil One. Many died in their attempts at flight; many others incurred grave injuries. But in every age appeared some man who was willing to learn, who took the mistakes of his predecessors as lessons, avoided their errors, and carried the study of flight a further step. History tells how for nearly twenty centuries men studied this greatest of problems, until at last, only a few years ago, the brothers Wright solved it.

Consider their riddles. They had to find just what supporting

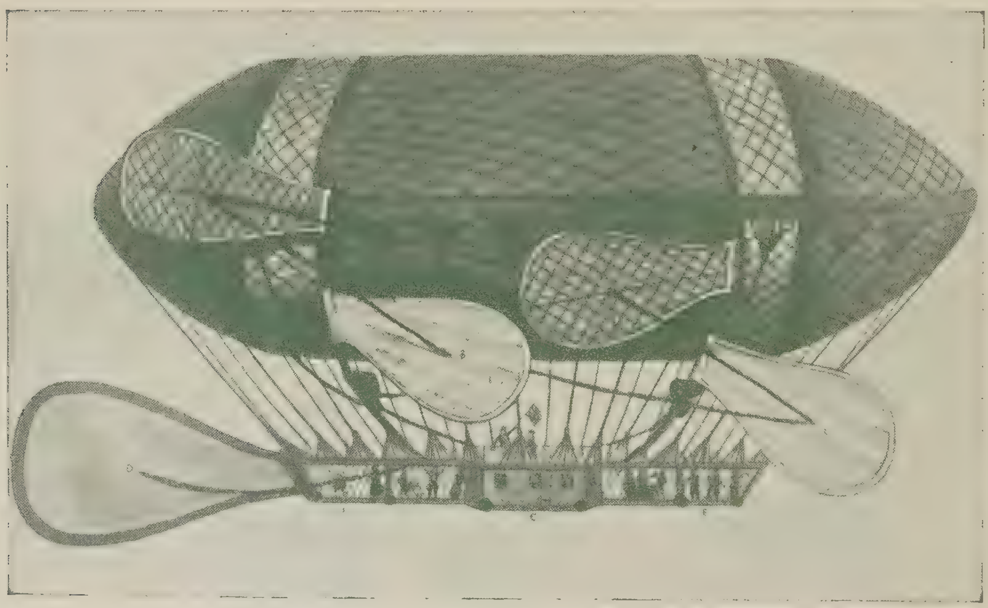
[S. N. A.

AN AEROPLANE OVER THE DOLOMITES.

These famous peaks were familiar to numbers of British travellers before the War, and not a few will envy the airmen their glorious view.

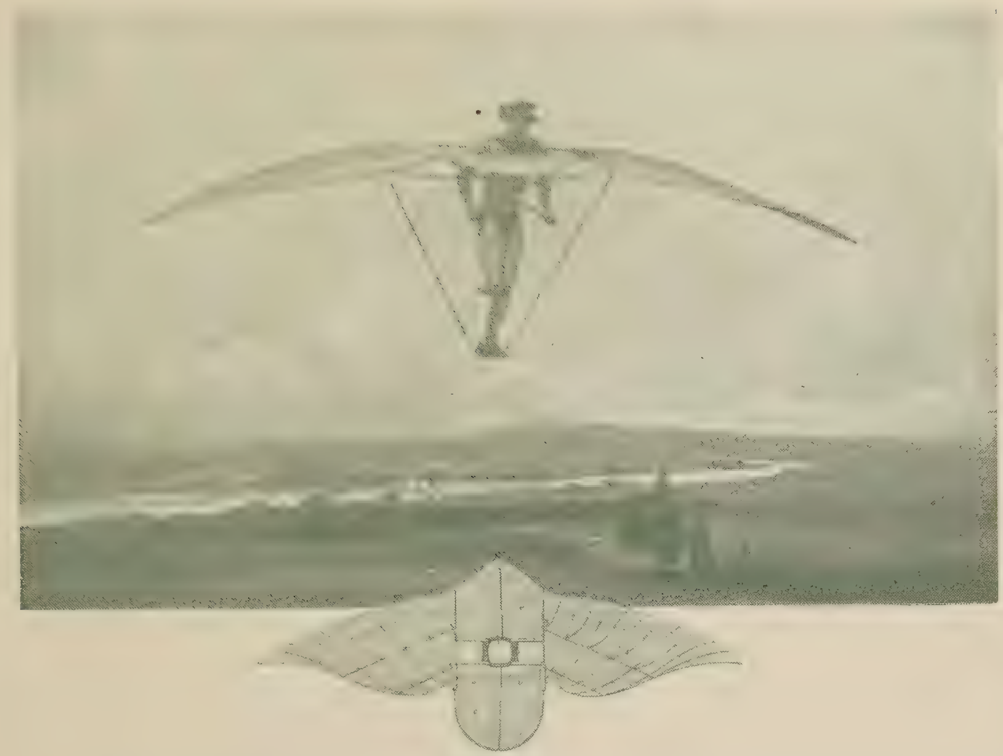
surface would bear the weight of man and machine; to ascertain what engine power was necessary to drive the planes at such a speed that the air would support them; to get a working knowledge of air currents; then, having learned to fly, they had also to learn to land on the earth—the most dangerous part of the whole business. They had to attack the problem with a number of fallacies in existence that were looked upon as proved truths; for the history of experiments in flight is a history of the upsetting of accepted theories and the reversing of nearly all that had been considered settled. But if men had not worked all through the centuries, studying the details of flight and how it was to be accomplished, the world's greatest problem would not have been solved in 1903; hence the pioneers of early years, in spite of their sometimes ludicrous ideas and mistaken attempts, are worthy of more honour than is generally given them.

An English monk, Oliver of Malmesbury, is often mentioned among early experimenters. He made wings that he attached to his hands and feet, and, attempting to use them, crippled himself for life—this was just before the Norman Conquest. The next serious attempt seems to have been made by an Italian, Giovanni Danti,



THE FIRST NAVIGABLE AIRSHIP, "THE EAGLE," 1834.

The disadvantages of the non-steerable balloon were soon realized. The above represents an early attempt to construct a navigable balloon, four net-covered wings or flaps on each side being used for propulsion and the steering accomplished by means of a cane-covered rudder. The vessel was 160 feet long, and was capable of carrying twenty-five persons.



THE AEROSTAT, INVENTED BY W. MILLER, M.R.C.S. (1843).

Nearly all early attempts at flight were based on the idea that man must imitate birds, and that it was possible to devise a substitute for wings which could be worked by muscular strength.

about the year 1500. Danti constructed some sort of gliding apparatus with which, on a festal day in Perugia, he set off from the top of a tower in the town, and "with a horrible hissing sound" flew a distance of about 250 yards, after which the main stay of the left wing of his apparatus gave way, and Danti fell on to a roof, injuring himself severely. Several writers of that time bear witness to the wonderful construction of the wings of this apparatus, and it appears that, up to the time of his accident, Danti's chief difficulty was in landing after one of his gliding flights. In this connexion it is worth noting that in modern flight landing is still the most difficult thing to learn.

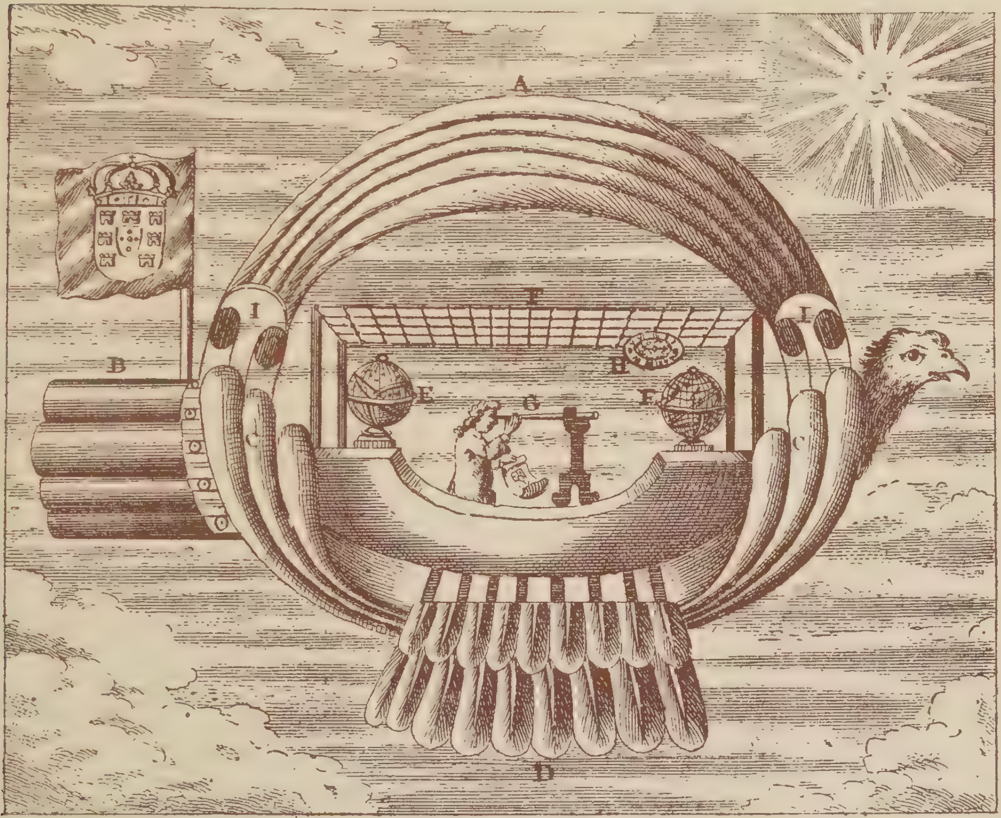
Most probably Danti based his designs to some extent on the suggestions of the great Leonardo da Vinci, who, in addition to being artist, engineer, and architect, made a study of the problems of flight, and especially of the flight of birds, for he considered that if the flight of birds were perfectly understood it would go a long way toward solving the problem of human flight. The genius of the man is shown in his *Treatise on the Flight of Birds*, a work in which he made observations and deductions that have been of great value to modern students of the subject. It was he who first found evidence of the existence of rising currents of air by observing how some birds would at times rise into the air with still wings. It was he who recommended that for the wings of a flying machine some covering impervious to the air should be used—this he learned from observing the wings of a bat; it was he, too, who pointed out that safety in flight lies in rising a good height above the ground, so that, in case of a mishap, one may have space and time to correct the trouble.

In addition to his treatise, da Vinci left a large number of drawings of parachutes and flying machines, the design of which anticipated modern methods of construction. Save for Danti and two others, nobody seems to have noticed his studies to such an extent as to profit by them. These others were Guidotti and Veranzio: Guidotti constructed a gliding machine of whalebone, the reputed covering of which was feathers, and with this made several short flights; the last of these is stated to have been over 400 yards in length, but, like Danti's, it ended with a fall on to a roof, and Guidotti broke his thigh bone. Veranzio constructed parachutes on da Vinci's designs, and experimented with them by launching himself from high buildings.

In 1678 came a French locksmith, P. Besnier, who designed an apparatus of rods and hinged flaps, with which he made gliding flights. The flaps were worked by the hands and feet, and Besnier practised first from stools and tables, then from windows and roofs. He did not claim to be able to raise himself in the air, but started from a height, when he could "easily cross a river of considerable size." His apparatus was looked on as an ingenious piece of work, but of little practical use.

In 1680 all the experimenters who had believed it possible to construct a practical flying machine that a man could work by his own muscular strength had their belief shattered by the publication of a book entitled *De Motu Animalium*, by J. A. Borelli, who stated, after investigating the subject, that flight by means of muscular exertion was quite impossible. Borelli's work is on much the same lines as that of the great da Vinci, and it put an end for a long time to the construction of flying machines, save for gliders and parachutes, which were used for sport and for exhibition purposes.

But interest gradually revived, or rather the world grew less and less inclined to accept Borelli's verdict, though he gave it with good reason. In the eighteenth century there arose a number of serious investigators, and quite a number of quacks as well; the former sought each to carry the study of flight a little way, the latter made preposterous claims with regard to what thay had done and could do. Thus Paucton, a French engineer, believed that a machine could be made which would enable a man to raise himself in the air by a geared horizontal propeller; and among the quacks was one Andrea Grimaldi, who claimed that in the year 1751, by means of a weird machine, he flew from Calais to Dover, and "from the London Park as far as Windsor Lodge and back, the whole in less than two hours."

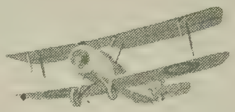


THE FLYING SHIP.

Designed by a Friar, Bartholomew Laurence de Guzman, chaplain to the King of Portugal, in 1709.

In 1783, the first hot-air balloon, invented by the brothers Mont-

HANDLEY PAGE



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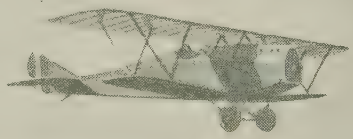

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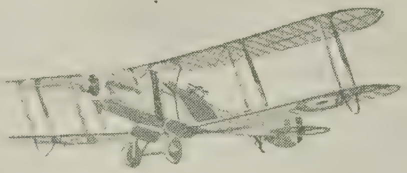
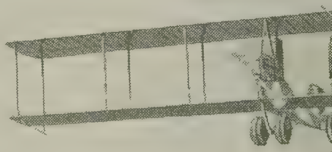
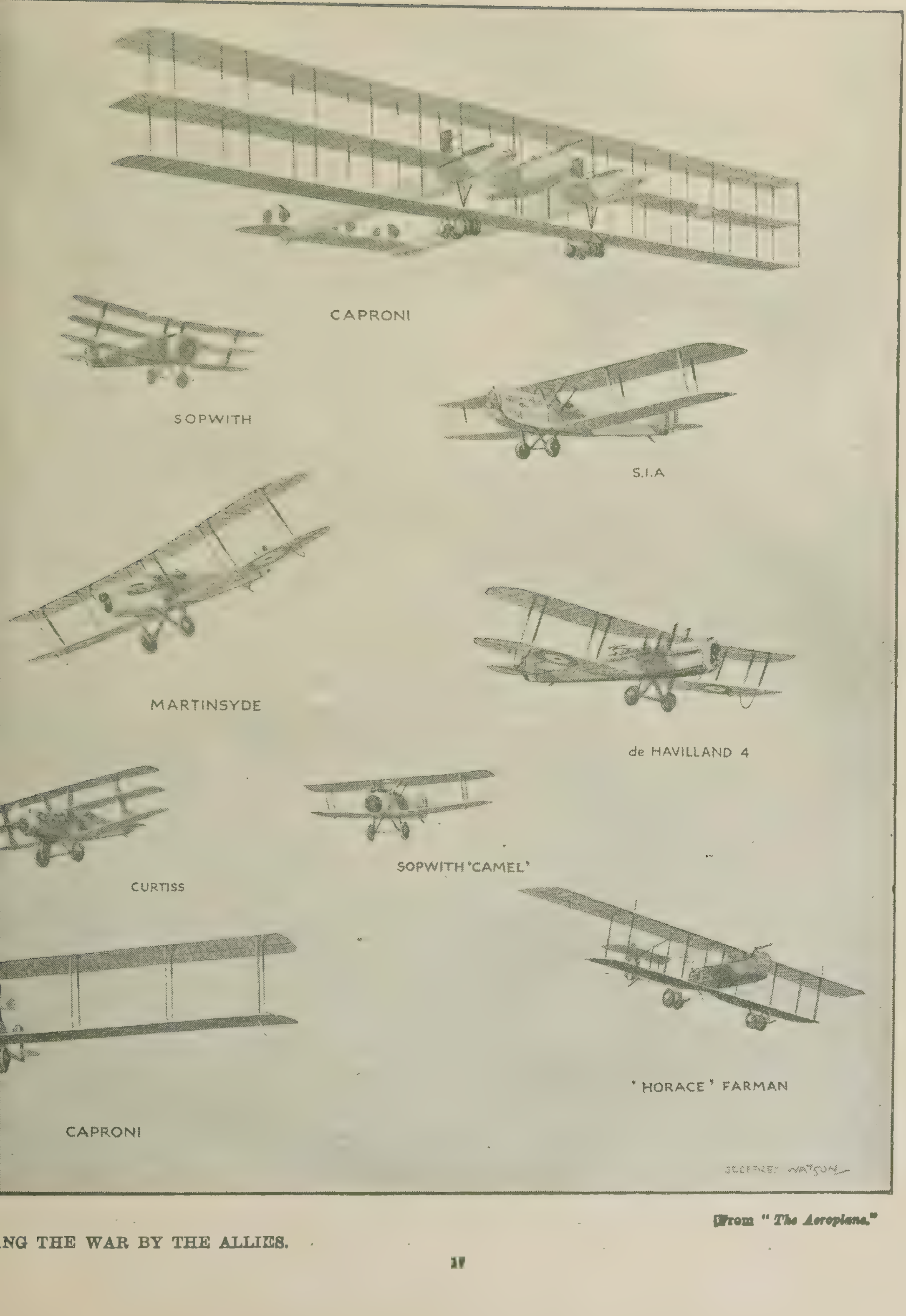


BRISTOL 'FIGHTER'



TYPES OF AEROPLAN



[From "*The Aeroplane.*"

NG THE WAR BY THE ALLIES.

golfier, went up at Versailles, and the men who would have solved the problem of flight by mechanical means considered themselves beaten—for a time. It was not realized at first that ballooning is not true flight; nor did men stop to consider that there is a great difference between a gas-bag, at the mercy of every wind, and a machine that can conquer the wind and shape its own course. At last men had actually risen in the air, had stayed there for an appreciable time, and had come down again without danger or discomfort. Everybody thought the problem of flight had been solved.

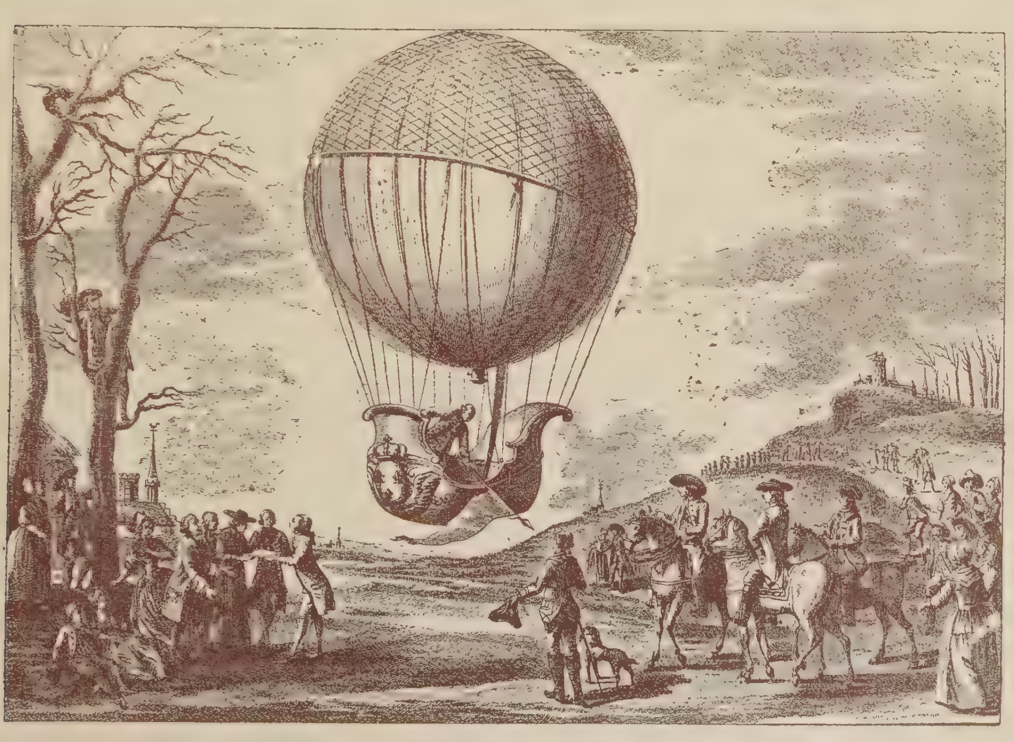
THE FIRST BALLOON ASCENT (Nov. 21, 1783).

An empty balloon, and one tenanted by unfortunate farmyard animals, had been sent up on earlier occasions, but this was the first time men ventured to ascend. The daring aeronauts were M. Pilâtre de Rozier and the Marquis d'Arlandes. They came down about 9,000 yards from the place of ascent.

It should be borne in mind that these early experimenters had not even the steam engine as a means of power, and that all, or nearly all, the observations of the air that the balloon afterwards made possible had not been made, save for da Vinci's careful studies, which had been neglected and forgotten. The man of that time who tried to fly had some vague idea of making wings which he himself could flap, or wings with a screw which he could turn. Stresses, wind-pressure, and similar problems, were utterly unknown—experimenters had to grope in the darkness of that ignorance which obscured all the Middle Ages, with none of the appliances or scientific advantages that the modern student can command. But with the little they had they wrought well. It is not to be wondered at that the balloon, apparently triumphing over the air, made a temporary end to the studies of real flight.

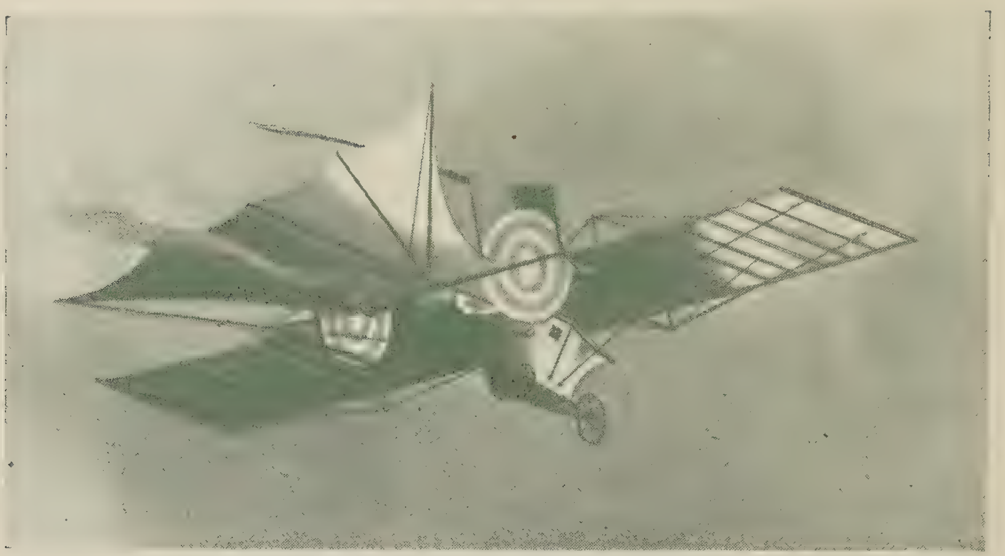
But no matter how many balloons man sent up, he could not be said to have really conquered the air, for even a balloon fitted with a screw propeller and given means of steering does not form a true means of flight; though it is probable that in the future the dirigible, or power-driven balloon, will be of almost as much commercial value as the aeroplane. Not many years after the first balloon ascended at Versailles, men again began to question: Was there not some possibility of achieving real flight?

Sir George Cayley, who is sometimes called "the father of British aeronautics," published the result of his questionings just at the time James Watt was perfecting the steam engine. Cayley put the matter



ANOTHER EARLY ASCENT.

The hydrogen gas balloon used by MM. Charles and Robert was a great advance on the crude "hot air" bags of the Montgolfier brothers illustrated on the preceding page. A height of 10,000 feet was attained, and one journey covered a distance of 150 miles.



"THE ARIEL STEAM CARRIAGE," 1843.

This machine was constructed by W. S. Henson, and, as will be seen, much resembled the modern monoplane in appearance. It could not, however, support its own weight.

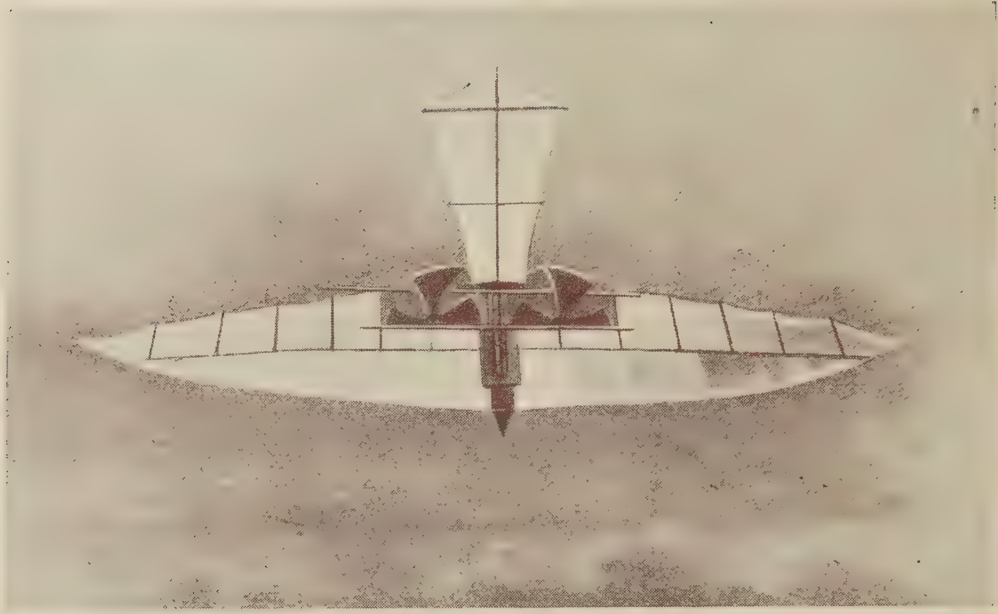
in a nutshell by stating that "The whole problem is confined within these limits—to make a surface support a given weight by the application of power to the resistance of the air." He saw that both vertical and horizontal rudders were necessary for steering aircraft, and foresaw that the ideal supporting surface of a flying machine must be slightly curved, or "cambered," as we say to-day. He also suggested the system of wire bracing for the wings. His work was mainly theoretical, but he settled many problems in connexion with power-driven flight, though nearly a hundred years were to pass before his suggestions could be practically realized.

The story of attempted flight in the nineteenth century is the story of the search for a driving force. When the steam engine came near to the form in which we know it now, many thought that this driving force had at last been found. Five years after Queen Victoria came to the throne, W. S. Henson built an aeroplane which much resembled the modern monoplane, and he got out designs for a steam engine with which to drive his machine. Henson's models actually flew, but lack of funds prevented him from making the machine itself a success. Others followed on the lines Henson had indicated, but one by one found that the steam engine would not give enough power for its weight—by the time one had got the engine, the fuel, and the driver as load, the whole was too heavy for the lifting capacity of the aeroplane. The only way to increase the lifting capacity was to make the aeroplane bigger, and this of course involved more power. Almost the last experimenter with steam engines was the late Sir Hiram Maxim, who built a huge machine of which parts may still be seen at the Victoria and Albert Museum, South Kensington. With this, on a trial flight, the inventor actually rose in the air, having with him two assistants; but the machine was badly damaged in landing. It was only an experimental machine, designed for ascertaining lift and air pressures, and though in theory it was a success, Maxim was too busy over other problems fully to develop the idea.

At the close of the nineteenth century came the ideal power-producing engine, the internal combustion motor. Between 1898 and 1907 road motoring developed enormously, perfecting the engine in various ways and fitting it for aeroplane work. The motor of twenty years ago was a very crude and heavy thing compared with the modern aeroplane engine, and aeroplane builders and designers owe much of their present success to the motor industry. It was realized some time before the Wright brothers actually flew that the

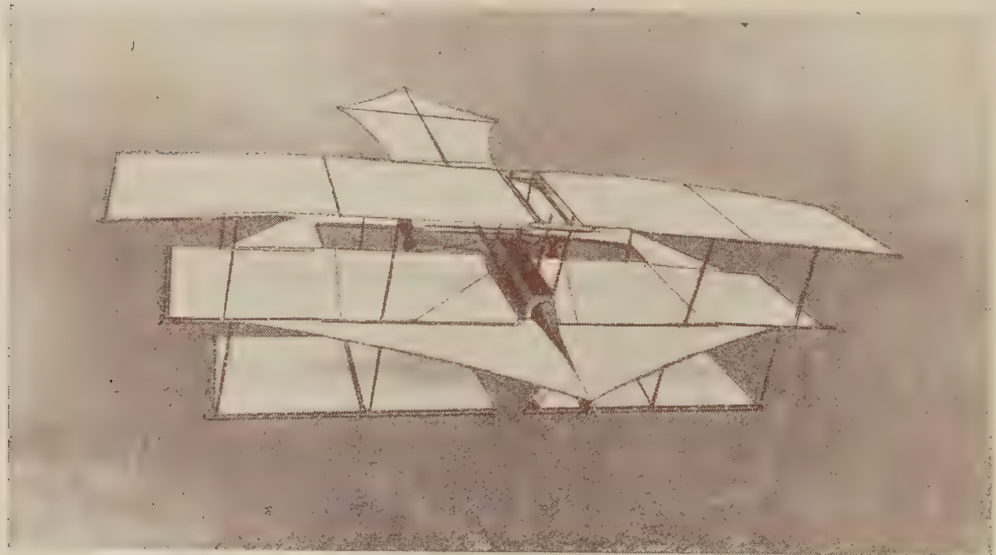
ANOTHER VIEW OF THE AERIAL STEAM CARRIAGE.

The wings were 150 feet long by 30 feet wide. The machine was driven by a 20 horse-power steam-engine. It has been described as "a splendid failure."



STRINGFELLOW'S AEROPLANE (1848).

This was the first engine-driven model to make a free flight. Steam was raised by spirit fluid. The machine was constructed on perfectly correct principles, all that was needed being the motor-engine and the petrol of to-day. The machine is preserved at the Victoria and Albert Museum, London. The light weight steam engine is in the possession of the Aeronautical Society.



STRINGFELLOW'S TRIPLANE (1868).

This machine, a development of that shown above, was flown at the first Aeronautical Exhibition, held by the Aeronautical Society at the Crystal Palace, in July 1868.

internal combustion engine had made flight possible, and that all that was needed to conquer the air was a combination of the right engine with properly constructed supporting surfaces.

Now observe the position. From the time of Cayley onward it had been said, " Certain flat or curved surfaces, driven with sufficient power, will enable man to fly. All we have to do is to get the power, and then make the supporting surfaces, and success is ours." This was all very well in its way, but every one of these men, Henson and Maxim included, overlooked the fact that, since no man had ever flown, nobody knew anything about the management of such a power-driven machine in the air, how it would behave, how the winds would affect it, how to land after a flight, and the dozens of other problems that beset the flying man to-day. Even the existence of what are known as " air-pockets," spaces which afford no support for an aeroplane, were unsuspected. To the nineteenth century pioneers ignorance was safety as well as bliss ; for knowing nothing of the air, or of the tricks it would play them, they would almost certainly have broken their necks had they got their machines off the ground.

[Central News.

THE FIRST AIRCRAFT TO CROSS THE ATLANTIC.

The United States Seaplane N.C. 4 arriving at Plymouth Sound (31st May, 1919). She flew from Newfoundland to the Azores, and, after a wait of ten days, from the Azores to Lisbon, and afterwards to Plymouth.

Two men realized that, in order to fly, you must know something of air problems from a practical point of view, and they attacked the matter from the other end. They built supporting surfaces, with which they launched themselves in the air, in order to ascertain just where the weight should be placed in relation to the supporting surface, how to steer the plane, and how to land. That is, they sought to ascertain first principles by actually getting into the air, considering that when they had mastered the elements of flight, it would be time enough to put an engine into a plane and attempt real flights.

These two men were Otto Lilienthal in Germany and Percy Pilcher in England. Lilienthal and his brother had experimented from childhood with supporting surfaces; and later in life Otto made himself a gliding machine, which was in effect an aeroplane without an engine. Then he constructed a conical hill, from the top of which he would launch himself on his glider and sail *into* the wind, not away from it. With this machine, and others like it, he made flight after flight, always experimenting so as to shape his surfaces for the best results, and patiently correcting his mistakes. Finally, he considered he had learned all that his gliders could teach him, and that it was time to fit an engine to one of them and achieve power-driven flight. In 1896 the power-driven machine was ready for the air; on the morning of August 9 Lilienthal made a last gliding flight before using the power-driven machine, and on that last glide he fell from a height of 50 feet and broke his spine—when his power-driven machine should have taken the air, he lay dying.

Pilcher built five gliders in all, and made many gliding flights, the best being for a distance of 250 yards. Like Lilienthal, he intended to fit an engine and propeller to the "Hawk," as he named his best glider, and, like Lilienthal, he died before he could put the plan in execution. He was giving a demonstration flight at Market Harborough, with his machine sodden by rain, and at a height of 30 feet the tail broke, the machine dived twistingly, and Pilcher received such injuries that he died two days later.

But these two men had not given their lives in vain. They had set down on paper the result of their investigations of gliding flight, and had shown just what was required in the form and pattern of the power-driven aeroplane. In France, Clément Ader attempted power-driven flight as early as 1897, and it is still a question as to whether he actually flew, as he claimed he did, or only "hopped," as the military report on the trials of his machine stated. In America Dr.

A RAID NIGHT.

P. S. Langley laboured for years, profiting by the work of Lilienthal and Pilcher, and building at last a machine which, but for the worst luck that ever befel a man, would have solved the problem of flight. Twice, when everything was ready for the trials of his machine, and it was launched, the launching gear fouled the machine and smashed it; and after a number of such accidents Langley could get no more funds to continue his experiments. It has been definitely proved since that his machine was fully capable of flight; the inventor's only mistake was in the method of launching by catapult.

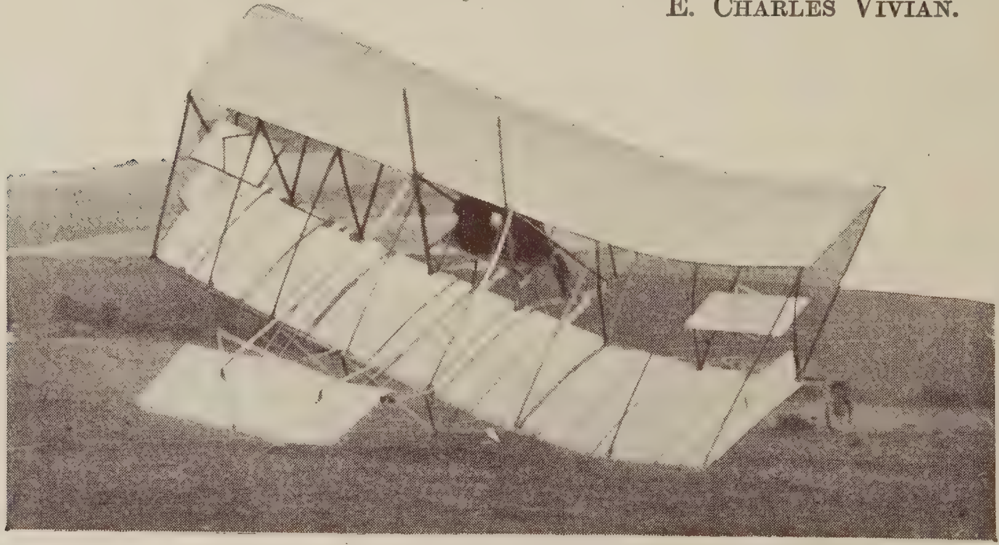
In the year of Langley's last accident, the two brothers, Wilbur and Orville Wright, achieved the conquest of the air, but their work was not done in a day. Over twenty years of patient work and study with gliding machines went to their success. Year after year they went into camp and made experiments, carefully recording the results and correcting their building and their balancing. They put the task quite simply: It was "to make the centre of gravity correspond with the centre of pressure." That is, to make the weight that the aeroplane must carry exactly balance in the air; a task made very difficult by the fact that every gust would tend to upset the balance, or, as they put it, to shift the centre of pressure away from the centre of gravity. This tendency they overcame by the use of rudders, and it is no exaggeration to say that, in settling this problem, they made with machines of different patterns some thousands of gliding flights. They studied thoroughly the flight of birds, and the action of the wind on curved surfaces; thus following the method of Lilienthal and Pilcher, trying to learn the air thoroughly before applying power to their machines. And they found out many curious things, among them the use of rising currents of air, and the existence of air "pockets," in which a machine will fall unaccountably. On December 17, 1903, with an engine fitted to one of their machines, they at last attempted power-driven flight; the first flight lasted 12 seconds, the fourth only 59 seconds. As the two brothers stood talking with friends about the flights, a sudden gust of wind struck the machine and wrecked it before any one could get at it. But they had flown—they had conquered the air.

But public interest in the accomplishment of the impossible was at first very slight. Some newspapers made mysteries of the doings of the two brothers, though they themselves made no secret of their attempts. After that first flight, they went on steadily improving their machines, and it was not until 1906 that any other man emulated them. In that year, Santos-Dumont, who had already achieved fame with dirigible balloons, made a flight on a biplane at Bagatelle, in France.

Soon the records of successful flights steadily increased, with regard both to distance and to time in the air. In September, 1905, Wilbur Wright made a flight of 18 minutes, and three years later his brother Orville stayed in the air for over an hour.

This short record of the solution of the world's greatest problem, while giving the main outlines, does not mention a tithe of the men who contributed to the conquest of the air. Many of them are half-forgotten, or wholly forgotten, but each in his way added a little to the final victory. We, who are accustomed to see aeroplanes up every day, may smile at the fantastic ideas of Oliver of Malmesbury, Danti, and their kind, but we should do well to remember that it was the courage of these early pioneers, and their faith that man would eventually triumph over the air, that kept flying alive, and stimulated others to attempt the solution of the problem. The history of flying goes to prove, in as great measure as the history of any other hard-won success, that no rightly-directed effort is ever wasted. And, in honouring the men who achieved the victory, it is only fair to remember, too, the men who made the victory possible.

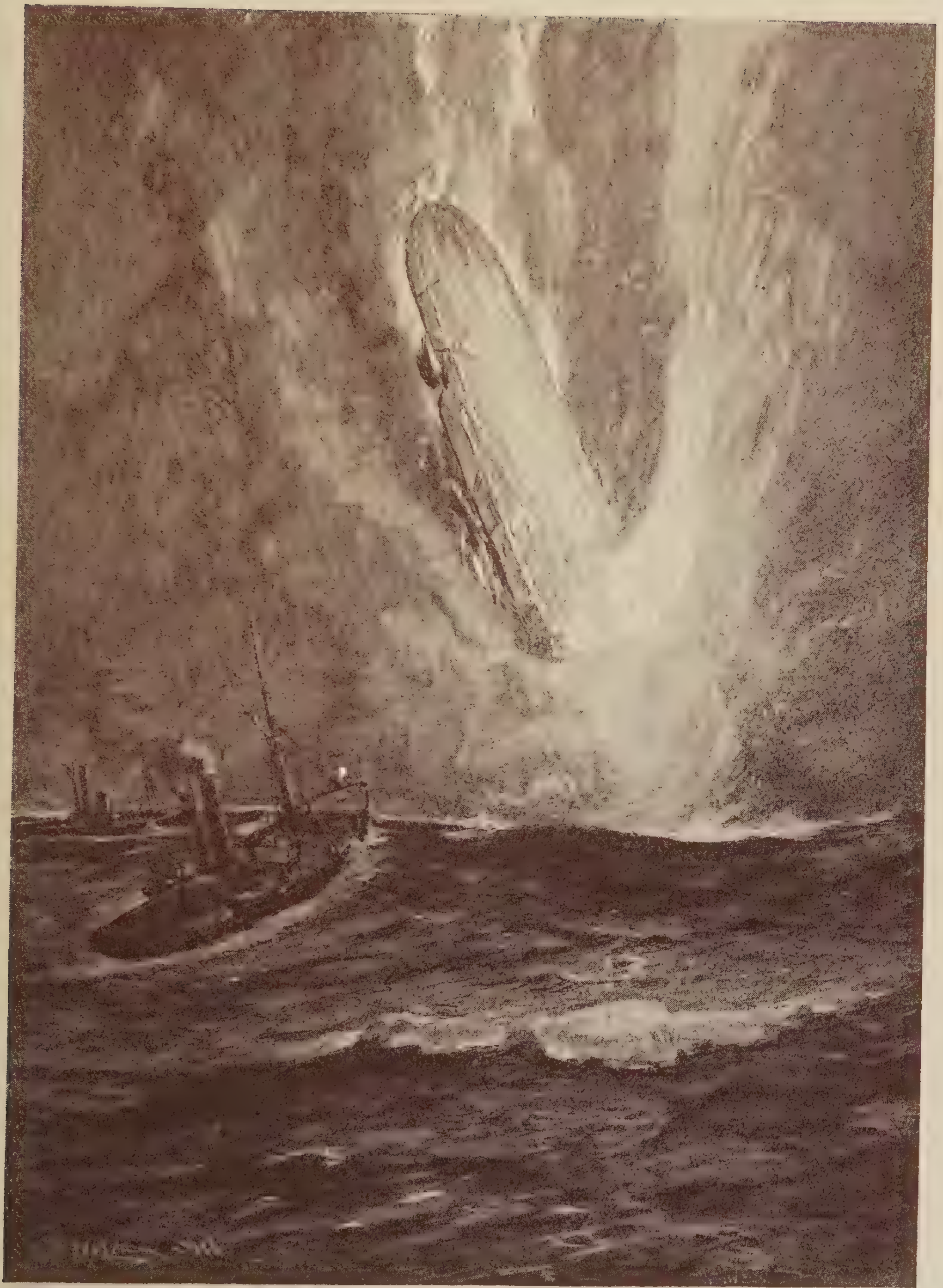
E. Charles Vivian.



[Cribb.

A GLIDER.

This machine, designed and constructed by Lieut. J. Porte, R.N., in 1907, was one of the Navy's earliest contributions to the science of aviation: It was launched from a slipway of wood and is seen gliding down Portsdown Hill.



JUST RETRIBUTION.

After a raid on defenceless towns in England, this Zeppelin was overtaken in the North Sea by a daring airman and brought down in flames. The illumination is said to have been visible for forty miles.

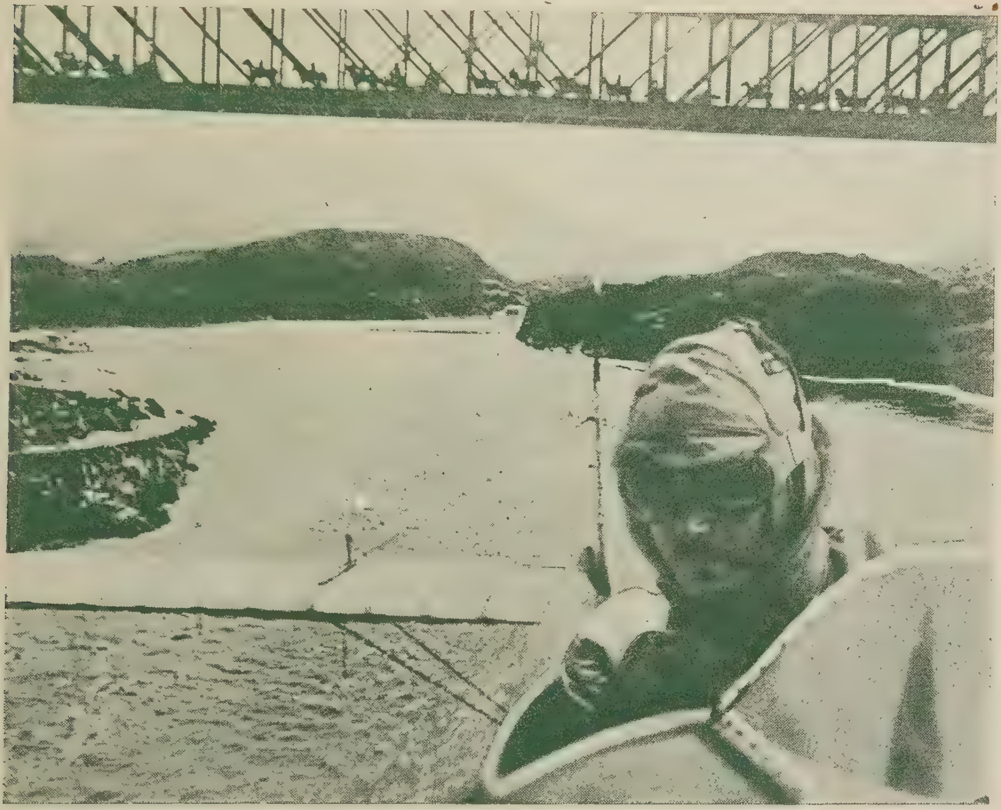
[Cribb.

THE EVE OF WAR, 1914.

During the historic Review held at Spithead in July 1914, great attention was aroused by the seaplanes which frequently flew over the Fleet. Little did those who looked on imagine how important a part this new arm was shortly to play in the defence of our shores.

The Royal Air Force

THE history of what is now the Royal Air Force is as eventful as it is short, for the Force has known a multitude of changes in the few years that have passed since the value of balloons in war led to the establishment of a "Balloon Section" of the Royal Engineers. For some time after aeroplane flight became recognized as a possibility, the "Balloon Section" retained control of all aerial military matters, but before the outbreak of War in August, 1914, the value of aircraft in military operations had caused the establishment of the Royal Flying Corps as a separate branch of the Army; and when the little British Army went overseas to endeavour to stem the first mighty onslaught of Germany, there went with it some two squadrons



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A DARING FEAT.

The pilot is seen flying *under* a river bridge, across which men and guns are passing. The photograph was taken by an observer in the same machine.

of aircraft, with flying men and mechanics. The total muster in those days of machines available for service overseas was 82 ; these comprised 80 h.p. Farman biplanes, Caudron and Short biplanes, together with Blériot, Nieuport, and Deperdussin monoplanes—a scratch lot, but one that rendered invaluable service. It was a pilot of the Royal Flying Corps who informed General Smith-Dorrien, in the days of the great retreat, that he had to face three German army corps instead of three divisions, as had been understood, and the wonderful retreat itself was only begun in time on account of the aeroplane scouting service.

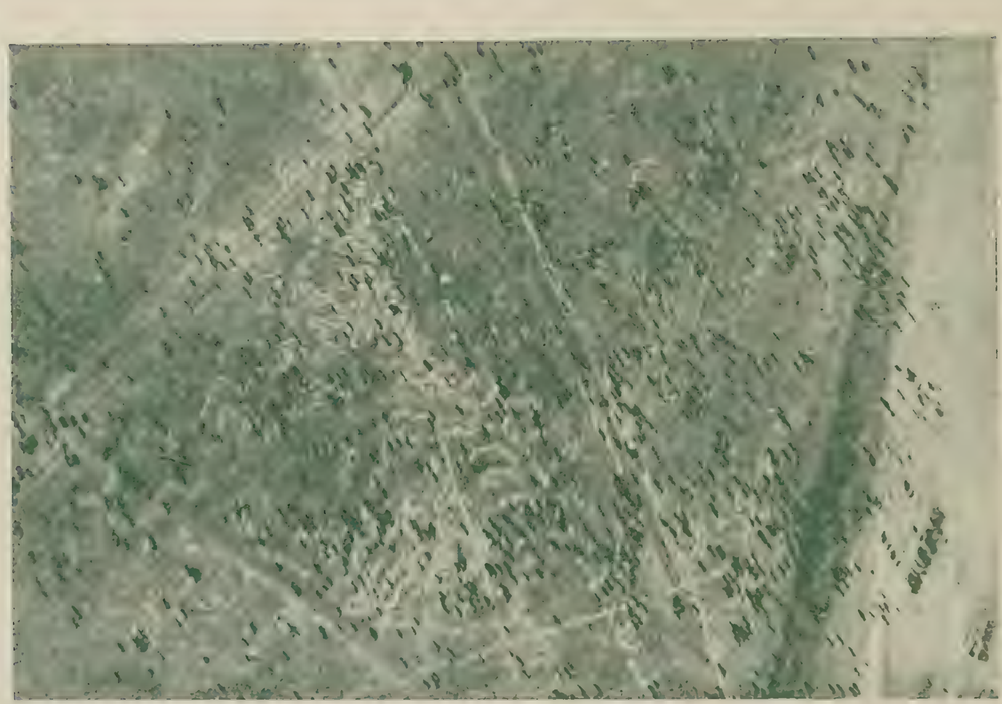
Germany, having given much study to the production of aircraft for war purposes, was able to outfly any of those early British machines, and the Royal Flying Corps performed miracles in keeping together a service until more efficient craft could be sent out. Gradually, however, more up-to-date machines replaced those that were lost, and as months went by the service was enlarged out of all semblance to the small body which went over with the first Expeditionary Force. The dauntless courage of British air pilots compensated for the poor quality of their material, for, until the famous German Fokker monoplane was beaten by the British De Havilland and F.E. (Fighting Experimental) types, the Germans had far the best of it as regards machines, for it

[*Canadian War Records.*

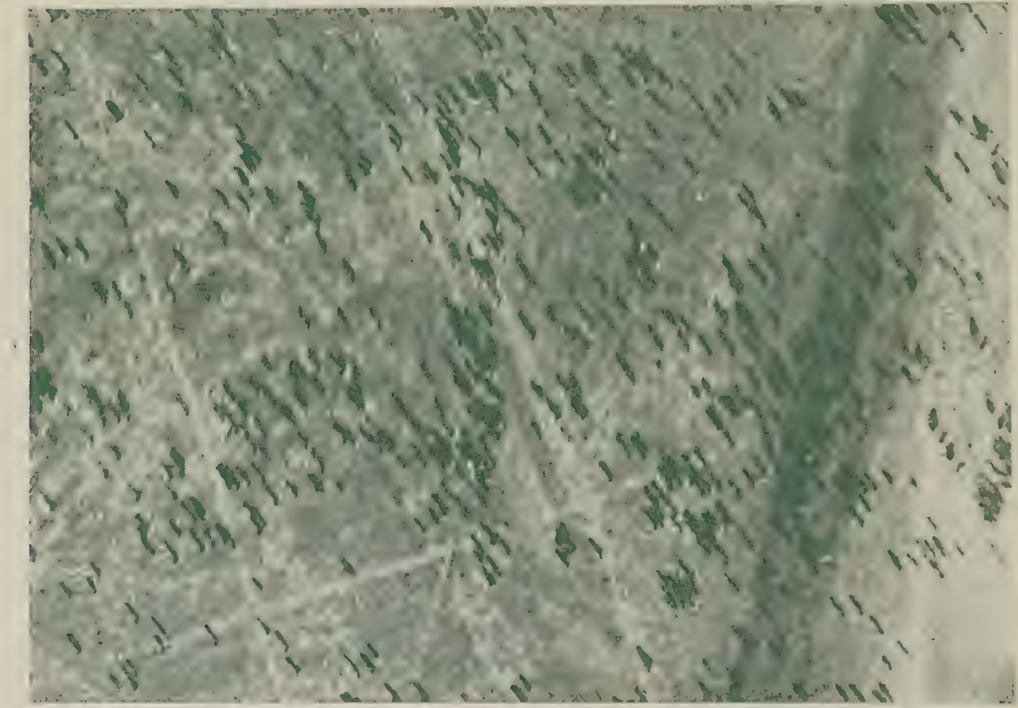
A GERMAN MACHINE FORCED TO DESCEND IN THE CANADIAN LINES.

A BRITISH AEROPLANE BOMBING AN ENEMY SUPPLY TRAIN IN THE BALKANS.

To accomplish their purpose the daring aviators came down as low as 50 feet. The driver and stoker jumped out in panic, and the train, deprived of control, hurtled along to its final destruction.



WHAT HUMAN BEINGS LOOK LIKE TO THE AIRMAN.



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A portion of the above photograph enlarged. Note especially the long shadows, which often prove most deceptive to an aerial observer.

takes time to design and complete any type of aeroplane for war purposes, and right up to the end of the War there was a six months' interval between the approval of a type of machine and the appearance of that machine in actual service.

The sea-going portion of the air service, then known as the R.N.A.S., was in somewhat better case. From 1912 onward the British naval authorities had recognized the value of seaplanes for naval scouting work, and more and better types of seaplanes had been developed than was the case with land aircraft. The work of the R.N.A.S. was of a very varied nature: there was naval scouting pure and simple, as when German ships tried to raid our shores; there was submarine spotting; coastal and other patrol work; and there was also co-operation with land machines in bombing German bases, both on the coast and inland. Zeebrugge, Ostend, Bruges, and Ghent, all important German air and naval bases, suffered quite as much from seaplane bombing as from military machines, while the failure of the German

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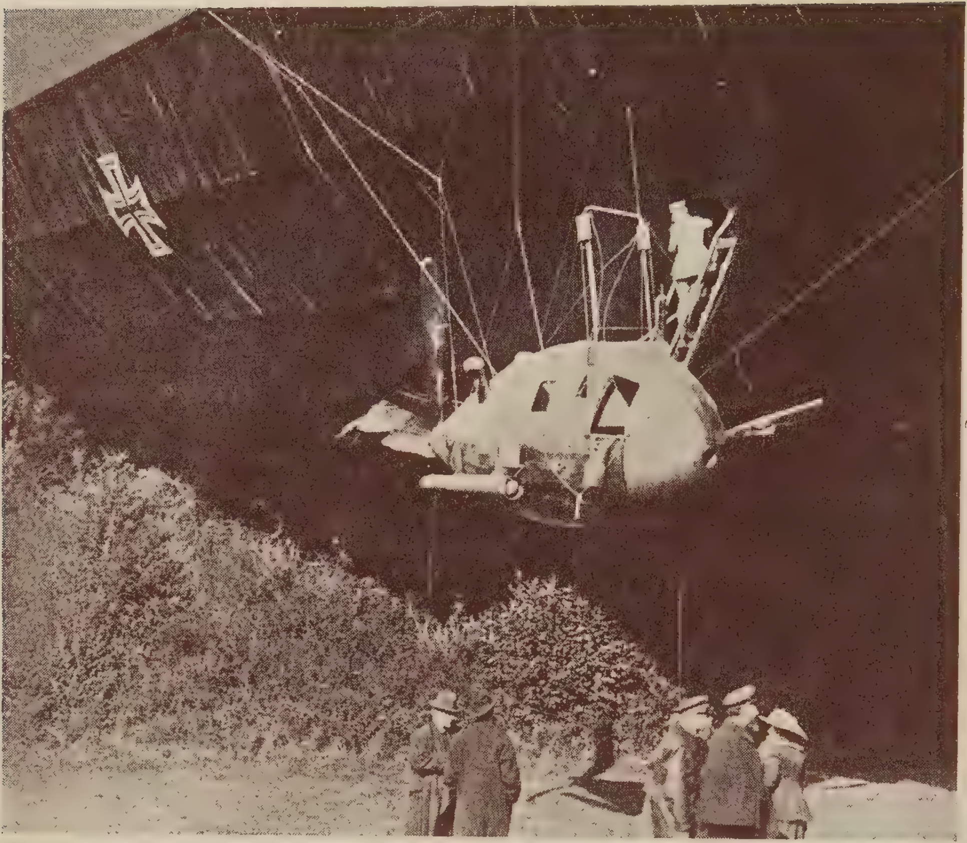
A COUNTRY HOUSE AND GROUNDS AS VIEWED FROM AN ALTITUDE OF 7,000 FEET.
Such a photograph is full of instructive reading to the Intelligence Department.



[Illustrations Bureau.

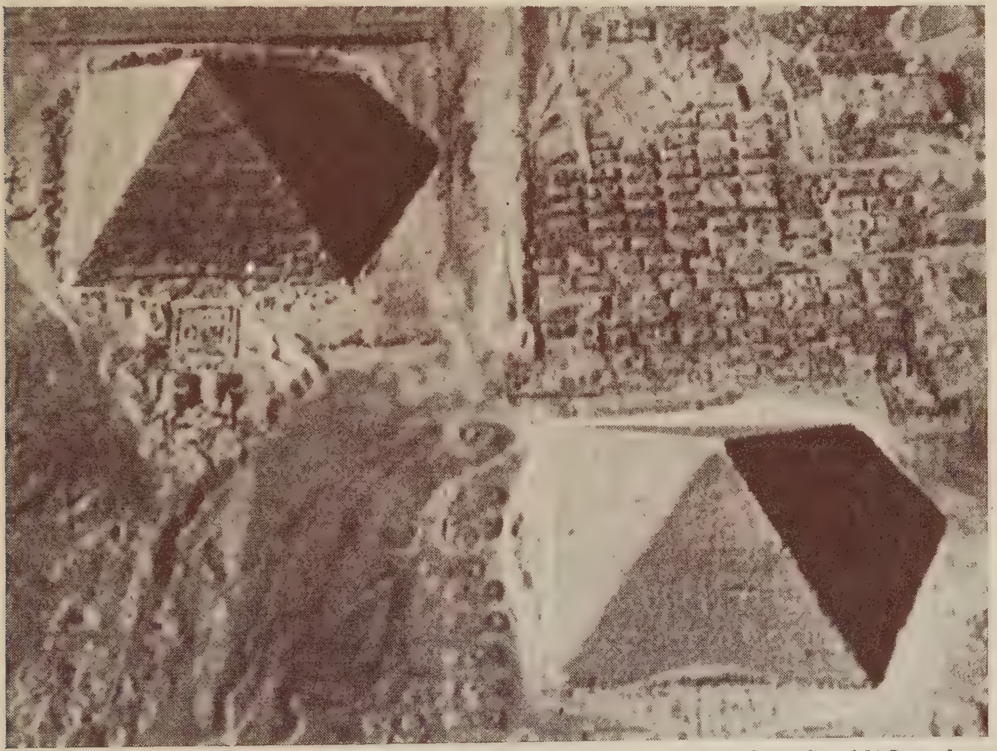
THE REAR GONDOLA OF A ZEPPELIN BROUGHT DOWN IN FRANCE.

Fleet to make any show in the North Sea, apart from " tip and run " raids on our coastal towns, was largely due to the good work done by the R.N.A.S.

As the War went on, both forces grew steadily, for it was soon realized that aircraft would play a part far larger than had been foreseen by any nation. Beginning the War with eighty-two machines and a staff of not much more than 2,000 all told, apart from the mechanics at the Royal Air Factory at Farnborough, Great Britain finished with a total Air Force strength of 30,000 officers, 265,000 men (including 21,000 cadets in training), and over 23,000 women. That is to say, in less than four and a half years the air services of Britain had grown until they were more than a hundred times as numerous as when War began, and until the signing of the Armistice the growth of the Force was continual, and the number of officers and men and machines was still increasing.

THE ROYAL AIR FORCE

Both the Royal Flying Corps and the Royal Naval Air Service, under their old names, rendered magnificent service to the country during nearly four years of strenuous warfare, and therefore some separate account of their work, apart from that of the Royal Air Force, is necessary. The Royal Flying Corps came into being just two years before the War began; it was formed from a few enterprising officers who had learned to fly in their own time and had obtained pilots' certificates at their own expense, and very soon it took over the "Balloon Section" of the Royal Engineers and carried on all the aerial duties of the Army. Up to the outbreak of War, it was anticipated that the whole work of the R.F.C. would consist of reconnaissance (helping cavalry to discover the movements of the enemy); but events soon



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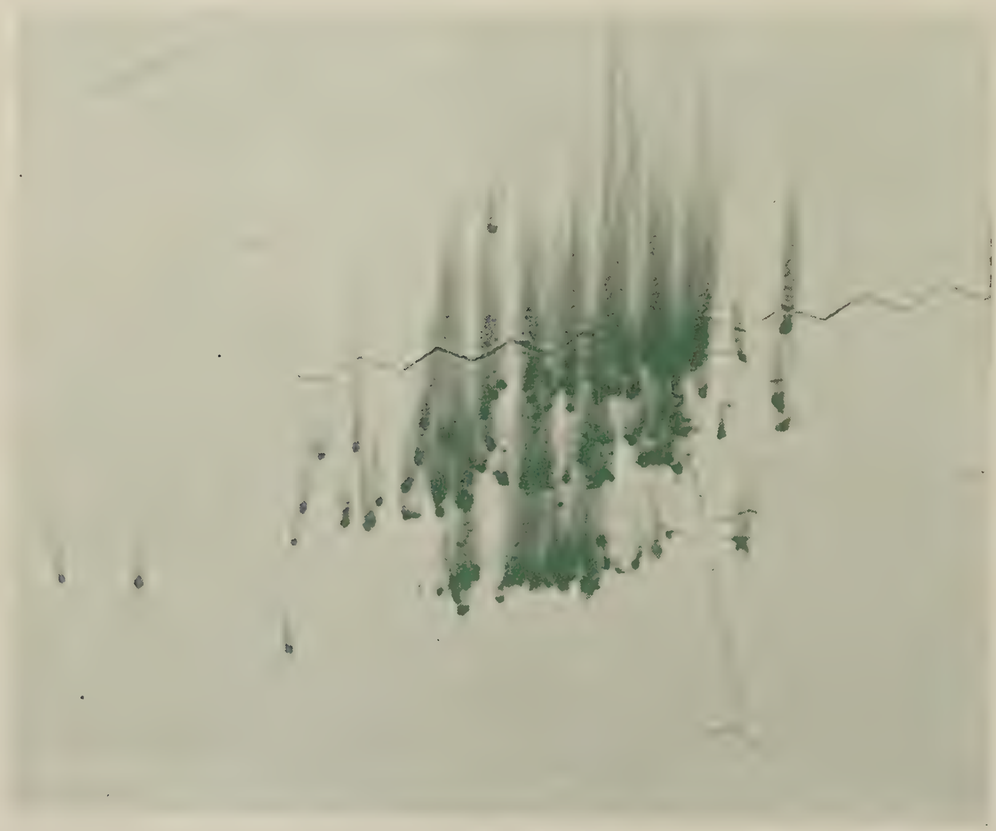
ANCIENT AND MODERN WONDERS.
The Pyramids of Egypt viewed from an aeroplane.

showed that reconnaissance involved much fighting in the air, and bomb-dropping on enemy troops, munition stores, trains, railway lines, and when possible aerodromes, was soon added to the general work. Then a French flying man took up a camera and obtained photographs of enemy positions, and, though those photographs were very poor things compared with those that were obtained later when particular attention had been given to this work, they showed that here was another field of activity for the aeroplane, and the Royal Flying Corps set to work to make a photographic section. Meanwhile it had been discovered that the fire of big guns could be directed far better from the air than in any other way, so yet another branch of work, generally known as "artillery spotting," was allotted to the Corps. This work, being very monotonous although very dangerous, was little liked by



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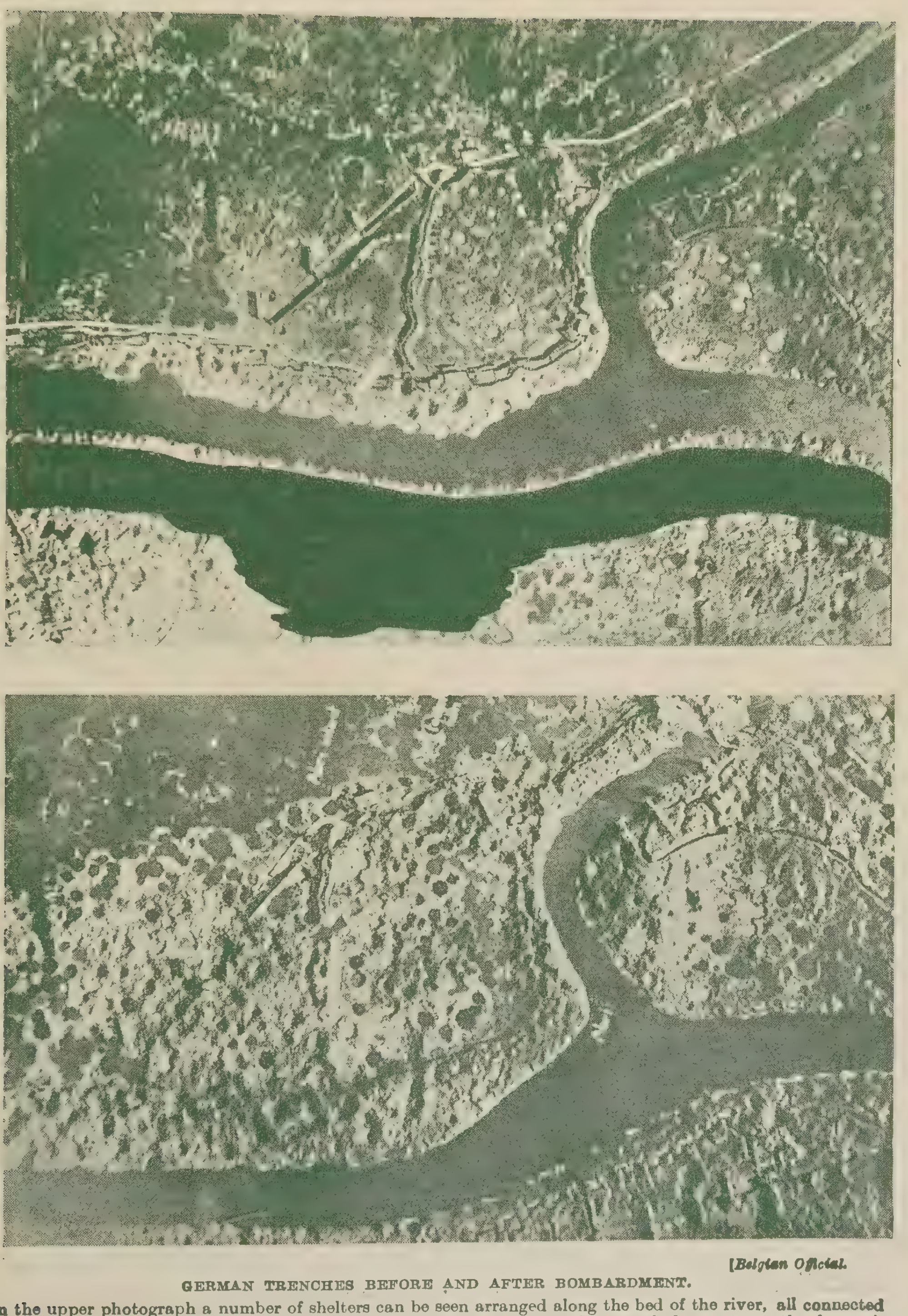
A LIFTING BARRAGE PHOTOGRAPHED FROM THE AIR.

The German trenches look like tracery in the snow. Note the lines made by the first and second barrage and the smoke of the shell-bursts in the third.



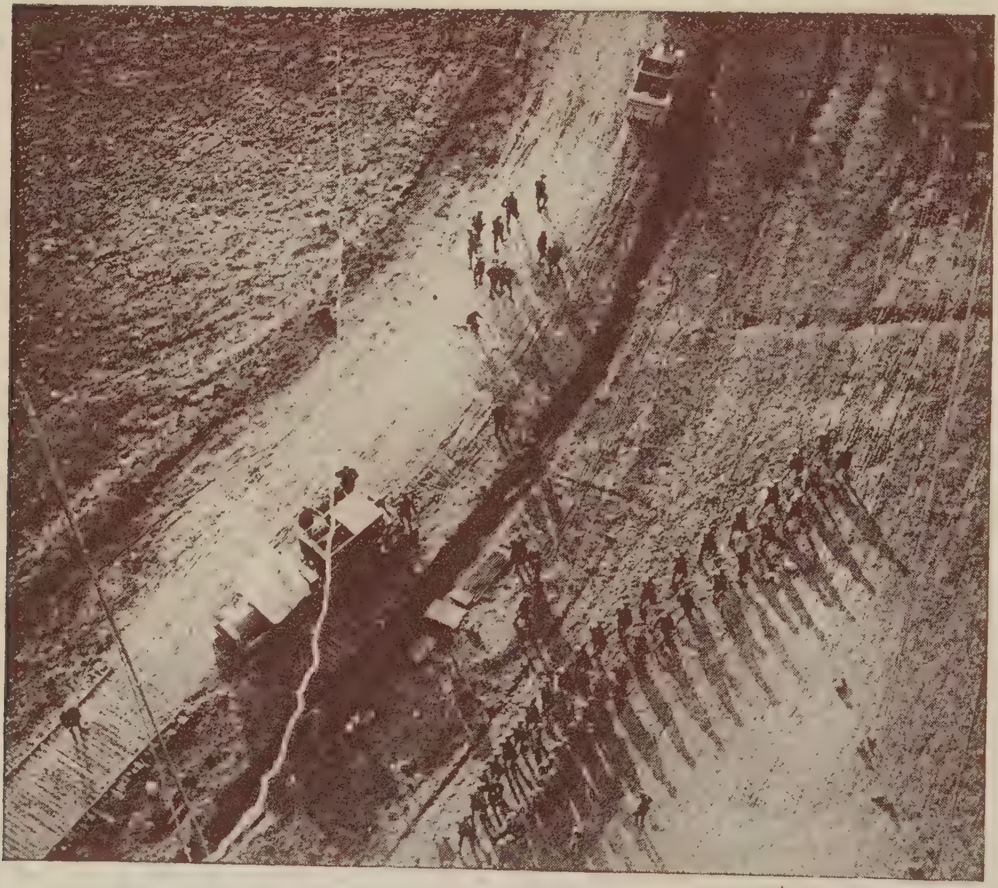
[Belgian Official.

GERMAN TRENCHES BEFORE AND AFTER BOMBARDMENT.

In the upper photograph a number of shelters can be seen arranged along the bed of the river, all connected with the main concreted way, which shows up white. The lower photograph demonstrates the thorough manner in which the Belgian batteries did their work.

the Corps in comparison with air fighting or bombing. Hardly a month passed, in the early days of the War, without some new use being found for the aeroplane, and the growth of the R.F.C. was never rapid enough, through the first three years, for military requirements. No matter how many men or machines went out, more and more were always wanted, for it was understood that the war in the air would go a long way towards deciding the war on the ground, as was indeed proved in the last year, and especially in the last few months of hostilities.

Some idea of the work accomplished by the Royal Flying Corps may be gained from the statement, made in the House of Commons, that in one day our airmen were the cause of the destruction of 127 hostile batteries, while 28 gun pits were destroyed and 80 damaged,



[*French Official.*

PHOTOGRAPHY FROM THE AIR.

A kite balloon has just ascended and the attendant mechanics are seen marching back to their station.

[*Central News.*

COAST DEFENCE.

The Royal Air Force maintained during the War a ceaseless coast patrol by means of small "S.S" (submarine spotters), generally known as "Blimps." Two anti-aircraft guns are also shown ready for instant action.

and 60 enemy ammunition dumps exploded. As regards photography, in a single month 15,837 photographs were taken from the air. Pieced together by men specially trained for the work, these photographs formed perfectly accurate maps of the whole of the enemy positions, showing trenches, concentrations of troops, and all that the enemy endeavoured to hide, and rendering possible some of the great feats of the Army on the ground. The magnificent bravery of the men of the Royal Flying Corps, specially emphasized in such cases as those of Captain Ball, Captain Robinson, Lieut.-Colonel Bishop of the Canadians, and Major McCudden, gained at last the mastery over the Germans, and when the Royal Air Force came to be formed in April, 1918, the work of war flying was already half done—Germany had learned to fear the British flying man, and the threat of enemy superiority in the air, apparent in the first days of the War, had definitely disappeared.

The Royal Naval Air Service was an older growth than the R.F.C. As far back as 1910 a patriotic Englishman made an offer to the Admiralty to the effect that if they would allow a certain number of naval officers to learn flying, he would provide the machines, the only condition being that the Admiralty should be responsible for the repair of machines that were crashed. This offer being accepted, a few officers went down to Eastchurch, in the Isle of Sheppey, and there laid the foundation of the great organisation which eventually became the Royal Naval Air Service, which had, at the time it was merged in the Royal Air Force, a staff of over 40,000 officers and men. At the outbreak of War, the R.N.A.S. was still a small force, but it was thoroughly efficient, and its machines were considerably better and more adapted to their work than those of the Army. Like the Royal Air Force, the R.N.A.S. began to grow immediately the War began, though its growth was not quite so great.

ROYAL AIR FORCE.

DISTINCTIONS OF RANK, ETC.

[On the formation of the Royal Air Force in April, 1918, a khaki uniform was at first adopted. This is now being superseded by French blue as in No. 11.]

1. General.
2. Lieut.-General.
3. Major-General.
4. Brigadier-General.
5. Colonel.
6. Lieut.-Colonel.
7. Major
8. Captain.
9. Lieutenant.
10. Second-Lieutenant.
11. Later Uniform (Captain).
12. Pilot's Badge.
13. Observer's Badge.
14. R.A.F. Button.
15. Cap Badge.

CAPS.

16. General.
17. Field Officers.
18. Captain.
19. Lieutenant and Second-Lieutenant.
20. Later Uniform (Captain).

DISTINGUISHING MARKS OF AIRCRAFT.

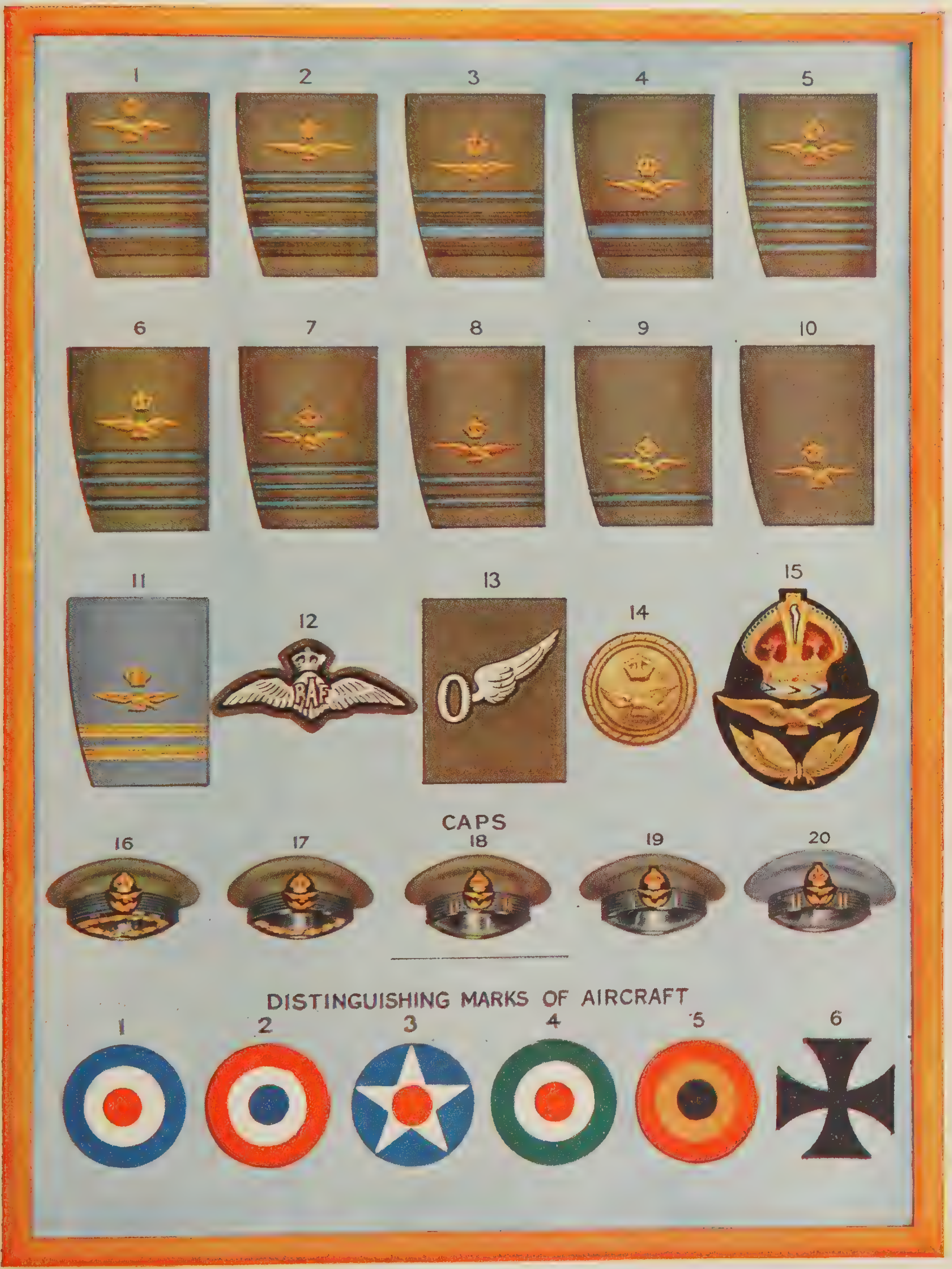
1. Great Britain.
2. France.
3. United States.
4. Italy.
5. Belgium.
6. Germany and Austria.

KEY TO COLOURED PLATE.

There was no theatre of the War in which the R.N.A.S. did not find employment, very often over the land as well as over the sea. All the air work of the Gallipoli campaign was done by seaplanes and R.N.A.S. men, who also took a considerable share in Egypt, Mesopotamia, Salonica, Russia, the Adriatic, German East Africa, and around the British Isles, to say nothing of the continuous work done over the Flanders coast. Submarine hunting and the escorting of troopships and merchant vessels was everyday work, while the R.N.A.S. accompanied the Grand Fleet into action and carried out offensive operations against the Zeppelin fleet accompanying the German High Seas Fleet.

A further form of activity that was confined to the R.N.A.S. was the control of the " gas-bags," or lighter-than-air craft, of the

ROYAL AIR FORCE.
Distinctions of Rank, etc.



For Key to Numbers see previous page.
The Khaki Uniform is being replaced by French Blue, as in Nos. 11 and 20.

British service, which, apart from the military uses of observation balloons, was purely naval in character. The "blimps," or small airships used for coastal and other patrol work, were exclusively manned from the R.N.A.S., and the later semi-rigid and rigid British airships, up to the formation of the Royal Air Force, were under the sole control of the R.N.A.S. All round the south and east coast of England the R.N.A.S. stations, with great sheds for airships, or hangars with launching ways down to the water for seaplanes, were to be seen during the War, and some of them have been retained as permanent coastal defence stations.

[*British Official.*

A BRITISH NAVAL "C.P" (COAST PATROL) AIRSHIP.

These vessels, rather larger than the "Blimps," did excellent work in locating minefields, spotting submarines and acting as convoys to merchant ships. The trefoil shape is given by the suspension of the car internally from the junction of the three lobes.

One result of the extended use of seaplanes for purely naval work was the creation of "parent ships" in the Navy—that is, ships devoted solely to the housing, repair, and launching of seaplanes. These ships are known as "seaplane carriers," and during the War numbers of them, some of great tonnage and containing a vast quantity of complex machinery and devices, were used. From half a dozen to a score of seaplanes could be carried on each ship, which was capable of keeping them in serviceable condition, even to supplying a new pair of wings, an engine, or half a dozen propellers at need. This gives some idea of the vast requirements of the Service, which, in order to be ready for any eventuality, had to maintain its own workshops afloat while the War lasted.

Another development of the sea service was that of carrying land machines on battleships, where they were launched for scouting work from special platforms, usually built over the great gun turrets. The reason for this was that the land plane was always speedier and handier in the air than the seaplane, owing to the less resistance of the landing wheels to air pressure, compared with the floats of a seaplane; the one great drawback of these machines was that, unless they could get over land at the conclusion of their tasks, they had to drop into the water and be hauled aboard, with a certain amount of discomfort, if not of actual danger, to their pilots. Their capacity for rapid climbing and their great speed rendered them peculiarly useful for certain naval tasks, while for others the slower but sturdier seaplane was more effective. Thus the R.N.A.S. was thoroughly amphibious in character, using some of its own machines for land work, as when bombing Zeebrugge and Bruges, and using land machines at times for sea work.

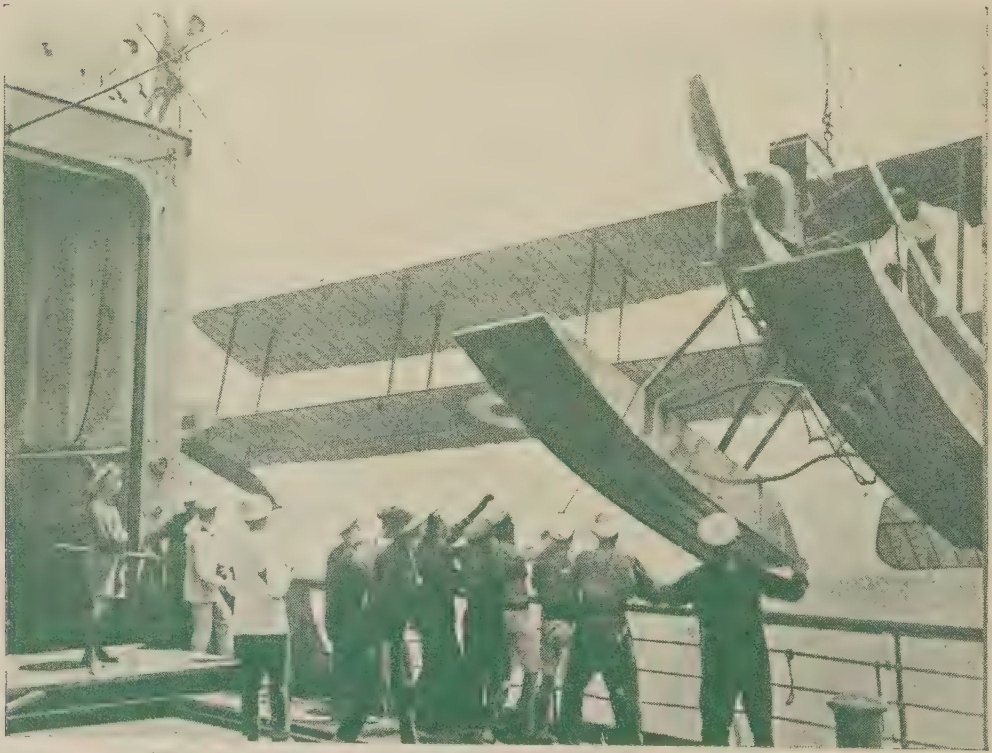
Another of the functions of the R.N.A.S. was that of "spotting"

A GERMAN SEAPLANE LEAVING THE WATER. [E. N. A.

BRITISH SEAPLANES AT BOMBING PRACTICE.

A fast motor launch is seen towing a target. The aircraft circle at various altitudes above, dropping their bombs in turn.

from observation balloons held captive in the air from observation balloon ships. These are ships from which the whole of the forepart has been gutted, leaving a great, deep well, into which the balloon is stowed when not in use. When the balloon is deflated, it is covered over by a movable deck, so that even an enemy aeroplane flying overhead has difficulty in recognizing the ship as a balloon carrier. As the gas begins to enter the balloon, after the movable deck has been taken off the containing well, and the envelope of the balloon fills out, it looks for all the world as if a peaceful merchant ship were suddenly developing a painful blister. But gradually the balloon takes on its true shape and rises above the deck, carrying with it the basket car in which the observer seats himself. A wire rope, winding off a drum, tethers the balloon to the ship, and regulates the height to which it is to rise for observation purposes. As soon as the balloon reaches the required height, the ship steams slowly about in order to steady the balloon and, if within range of enemy guns, to make the task of



[*Illustrations Bureau.*

HOISTING A SEAPLANE OVER THE SHIP'S SIDE.

The "mother-ship," it will be seen, has a hangar on deck.

[British Official.

LOWERING A SEAPLANE TO THE WATER.

hitting either ship or balloon more difficult for the enemy gunners. But, no matter how much steadying may be done, the work of the observer is worse than if he were in a small boat on a rough sea, if there be ever so little wind, while when the winds get stronger balloon ships have to pack up their " blisters " and retire to their bases.

Thus it may be seen that the work of the R.N.A.S. was even more varied than that of the military branch of the flying service, involving just as many risks, and calling for equal courage—which latter, it may be added, was never found wanting in the members of the Service.

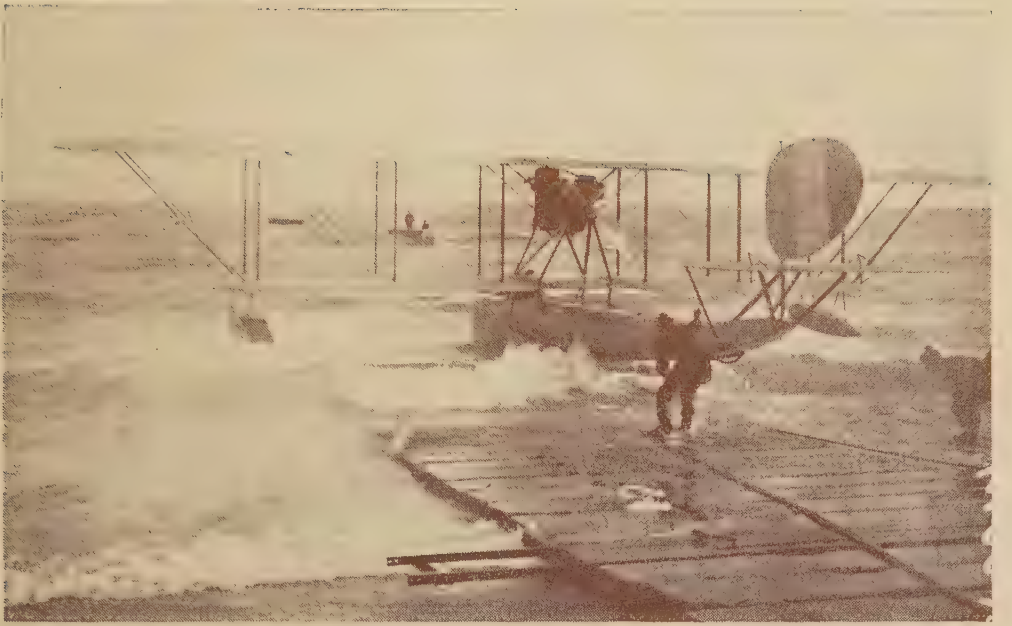
One point which may be made about the R.N.A.S. is that it did more for the improvement of the flying machine than any other body in the world. Being a semi-independent body, built up from remarkably small beginnings, with no preconceived notions to clog its energies, it obtained, experimented with, discarded, and again took up machines of every make and kind. If a machine were tried and found wanting, it was scrapped without the slightest hesitation, and on the other hand if a machine were found good, although it had not official approval, there was no reason why the Service should not give it a trial. If it answered requirements, the designer and maker were encouraged, machines of this particular type were ordered, and suggestions made for its improvement. Within three years the R.N.A.S. obtained, through intelligent foresight and enterprise, machines that proved on the whole better than those possessed by any other flying force, Allied or enemy.

The magnitude of the work performed by this branch of the Service is shown by its work in a single month, during which, according to official figures, the distance covered by patrols was 170,000 miles, of which 90,000 miles was covered by seaplanes and 80,000 by airships of various types.

[Illustrations Bureau.

WRECKAGE OF A GOTHA BROUGHT DOWN IN KENT.

From the foregoing account of the varied and ever-increasing activities of both branches of the Air Service, it will be gathered that the fusion of these two services in one, under control totally separate from either Navy or Army, was practically inevitable. It was not so much the training of the men, but the obtaining of the very best types of machines in sufficient quantity, that was mainly responsible for the formation of the Royal Air Force in April, 1918. The officers and men of both the R.N.A.S. and the R.F.C. were given the

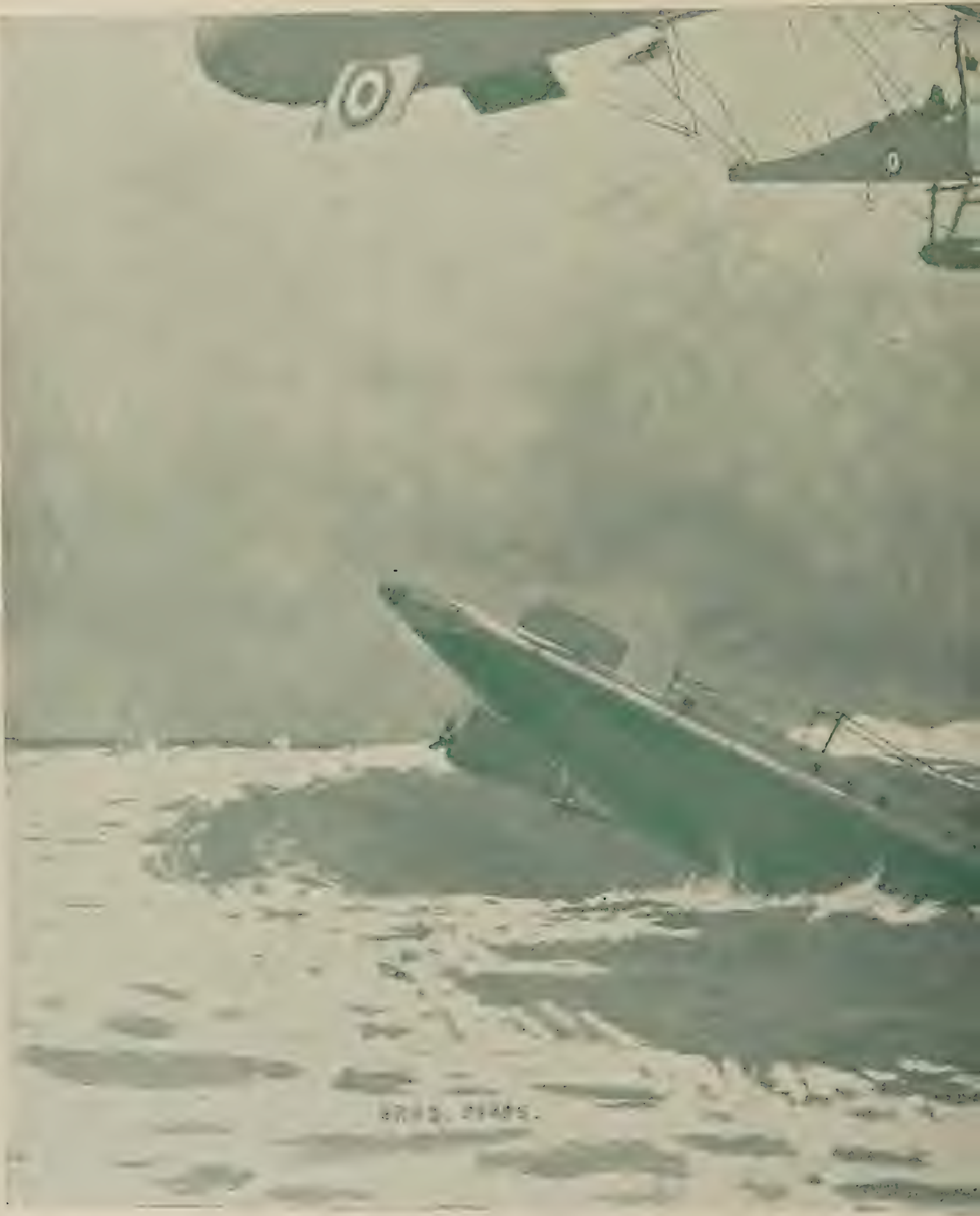


[French Official

A FRENCH SEAPLANE "TAKING THE WATER."

[French Official

"GETTING OUT."



FIGHTING THE

A British airship on patrol duty, having sighted an enemy submarine, has signalled a destroyer by wireless, and the destr
alone was more than two tim

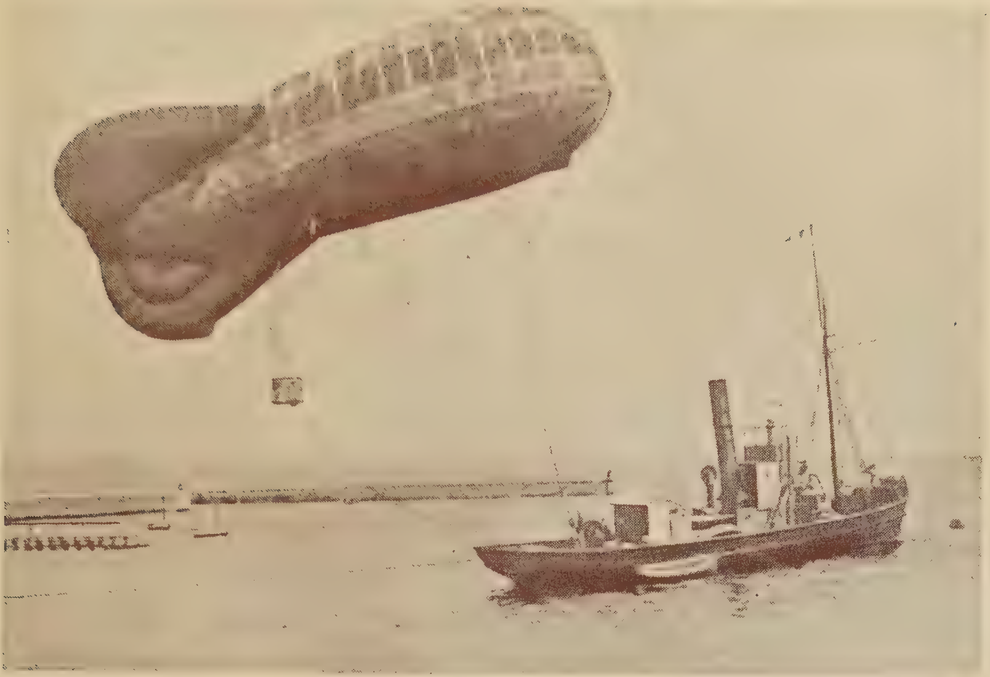
PERIL.

rest." It was officially stated during the War that in a single month "the aircraft patrol round the British coast
erence of the earth."

option of continuing in their old services, or of transferring to the new Force, but all enlistment for air service was confined, from the time of formation of the R.A.F., to that body, which took over control of air work by land and sea, save for certain naval activities which remained under the control of the Admiralty, since they were so closely allied to naval work that it was better for purely naval authorities to direct them. So far as land work was concerned, the Royal Air Force took over full control from the military authorities, although, of course, military duties were carried out in concert with the leaders of ground operations, and the work of the Royal Air Force was devoted to co-operative action with guns and infantry against the common enemy.

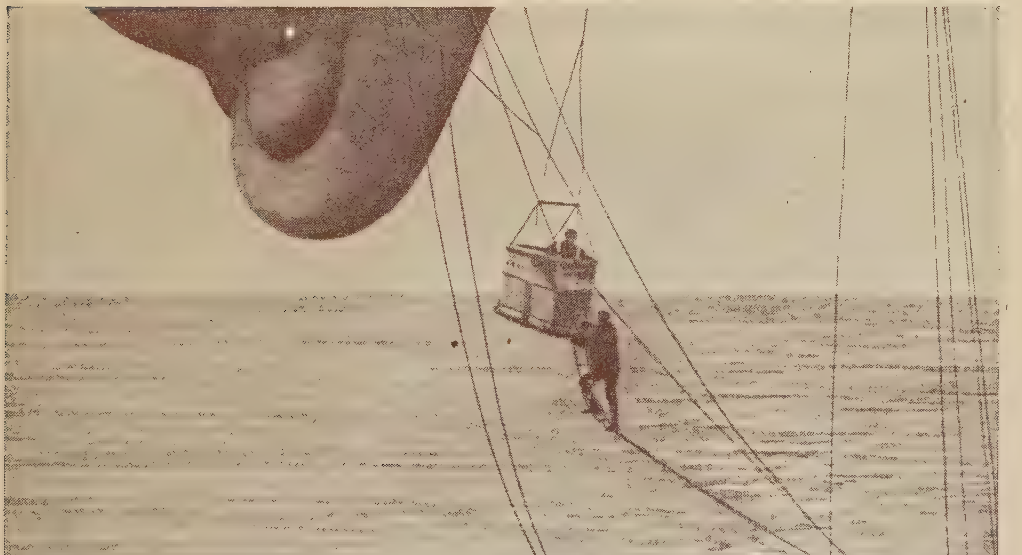
The benefit of the change to a separate control was mainly felt in the increase of machines available for service. Although the Force was only constituted early in the last year of the War, there was an immense growth in its material equipment by the time the German offensives came to an end and the series of Allied onslaughts which brought about the enemy defeat began. Also there was discovered a fresh task for the flying man: short-range gunnery came into vogue during the German offensive, and soon men were being specially trained to fly very low over the enemy lines, and by means of machine-gun fire to break up formations of men, guns on the march, baggage trains, and in fact any and every enemy formation. It may be said in passing that up to the end of the War the Germans never copied this form of fighting with any marked success—they had not the nerve necessary to ensure good work at such short distances from the ground, and in such danger from artillery and rifle fire.

Both the Royal Flying Corps and the Royal Naval Air Service had established a series of fine traditions in the comparatively short period between their formation and their fusion in the Royal Air Force, and the new Force fully maintained those traditions for the remaining period of the War. In the later stages, when machines and men were available in quantities unthought-of in early days, time and again the action of the flying men changed the fate of a battle. Especially was this notable in the last German retreat from the Marne, when the flying men kept the river crossings under fire day and night, co-operating with artillery and rendering the passage of the river terribly expensive for the enemy. Again, when the great Allied



[*Illustrations Bureau.*

AN OBSERVATION BALLOON AND ITS ATTENDANT TRAWLER.



[*Illustrations Bureau.*

AN OBSERVER CLIMBING INTO THE BASKET.

advance began, the Royal Air Force broke up enemy reinforcements, spoilt the enemy's attempt to delay the British and French by artillery work, spotted concentrations and demoralized them, and practically drove the enemy's aeroplanes out of the sky. The final victory of the Allies was largely due to the magnificent work of the Royal Air Force.

One of the leaders of the Force, General Trenchard, who was largely instrumental in the organization of the Force itself, was given command in May, 1918, of what was termed the Independent Force, R.A.F., a selected body of flying men and machines devoted entirely to upsetting German war industries by means of long-distance bombing raids. In twin-engined machines, each capable of carrying up to four tons of bombs, the members of this force went out in squadrons of varying strength to the towns of the Rhine and Saar valleys, destroying or damaging military railways, blowing up blast furnaces, wrecking factories in which poison gas was manufactured, stopping whole towns from their work of making guns and munitions, and causing incalculable damage to the enemy's military plans by work behind his lines. Practically every town of the Rhine provinces was visited by the Independent Force at some time or other during 1918, and the work of these squadrons steadily increased up to the end of the War, although it involved great strain on the pilots, and called for much skill in the navigation of exceptionally long distances, as well as ability to drop bombs with accuracy and to fight the squadrons that the enemy sent out to repel invaders over his territory. The work of the Royal Air Force as a whole was so efficient that, in the last months of the War, practically all the air fighting took place over the enemy lines, since the German airmen dared not venture over the Allied lines.

So far as the future is concerned, the Royal Air Force is bound to take a large part in defensive measures in view of the possibility of other wars. Although there has been no attempt to retain the vast organization or the strength of the War period, yet the R.A.F. must be kept as a trained fighting body, able to take the field at need, and, as in the Great War, manned by the best and bravest youth of the country, of the type that has already made the Royal Air Force equal in service distinction with either Navy or Army, and able to claim recognition in company with the finest units of either for gallant service and devotion to duty in the face of danger.

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A TWO-SEATER FIGHTING PLANE PHOTOGRAPHED BY ITS ASSAILANT DURING A MIMIC BATTLE.

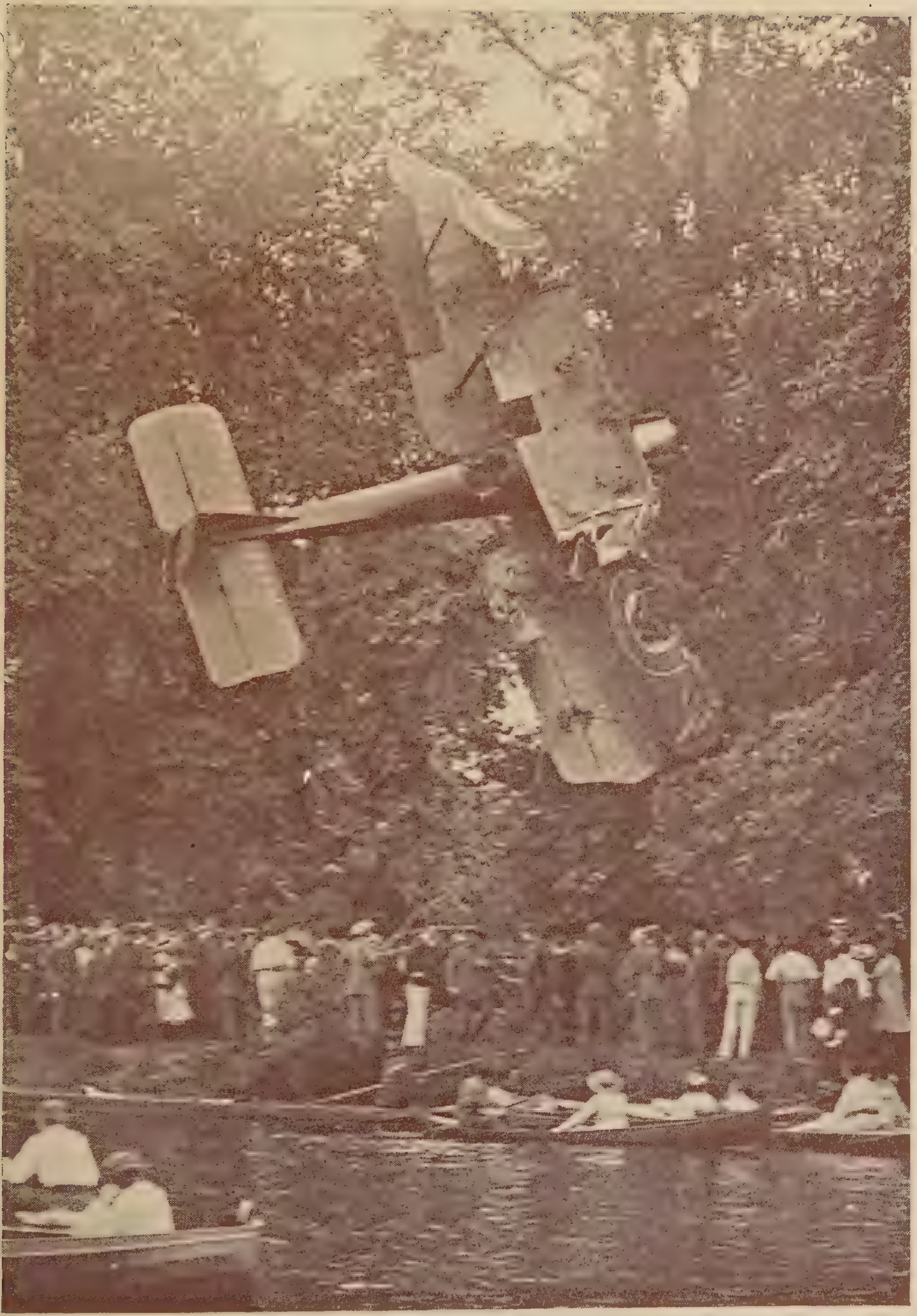
Why an Aeroplane Flies

EVERYONE knows why a balloon rises, and it is the merest commonplace to say that a balloon ascends in air just as a bubble rises in water because the gas which inflates the balloon is so much lighter than air that it tries to get to the top, or at least into those higher layers where the air is so thinned out that it is of no greater weight than the gas in the balloon and the weight which the gas is lifting.

The gas, the fabric of the balloon and the car and passengers together weigh less than the volume of air which they displace; therefore the balloon rises. But an aeroplane, independently of what it carries, is itself heavier than the volume of air it displaces. How then does it rise?

This is best explained by a simple analogy. A kite is heavier than the volume of air it displaces, yet a kite properly flown rises. It does so because its flat surface is held at such an angle that the pressure of air on the under surface is greater than the pressure of air on the upper surface. There you have the whole principle of aeroplane flight; an aeroplane rises because the propeller drives its inclined planes at such a rate as to produce a pressure on the under sides of those planes, and that pressure is sufficient to lift the whole thing off the ground and up into the air. Otto Lilienthal and Harry Pilcher, in the gliding flights described in the article on "The Conquest of the Air," offered such surfaces to the atmosphere as produced sufficient pressure on the under sides to enable their machines to fly for short distances without any propelling power; but they were well aware that propelling power would be necessary for continued flight. Earlier investigators hoped that man might fly as the birds fly, by his own muscular effort used in conjunction with supporting surfaces, but prolonged experiment proved that this was impossible; to maintain sufficient pressure against the under side of the supporting surfaces mechanical power was a necessity. How to get that power without adding too much weight was a puzzle until the internal combustion engine was designed; and for many years to come the main problem of progress in methods of flight will consist in producing an engine of less weight for a given lifting power.

Early in the history of experiments in flight it was noted that the wings of birds are always curved, so as to scoop as much air as possible with each beat, for obviously a concave wing will scoop in more air than a flat wing. Thus, at the very beginning of aeroplane flight, the curved wing was used. It was also noted that a bird's wing is much longer from root to tip than it is broad from front to back, or rather from head to tail end; this may be regarded as the root of the principle by which the lifting surfaces of an aeroplane are made as narrow oblongs rather than as squares. If one plane were made 10 feet square, and another 100 feet in length and a foot in depth, both would have the same surface area (100 square feet); but the long, narrow one would have much greater lifting capacity than the square one. But, since there is a limit to the length which planes can be made, owing to the difficulty of attaching long, narrow planes to the body of a flying machine, it is better to cut the long, narrow plane in half and to fix one half over the other, thus forming a two-plane machine, or biplane, the single-plane machine being known as a monoplane. Up to a point, this system of placing planes one over the other greatly increases lifting power; hence there are now comparatively few monoplanes being built, but plenty of biplanes,



[*News Illustrations Co.*

A RIVERSIDE CATCH.

After giving a holiday "show" at Hampton Court, this machine got entangled in telegraph wires and finally crashed into a tree.

while triplanes, having three layers of supporting surface, and even quadruplanes, with four layers, are made. Multiplanes have even been built which have much the same appearance as a Venetian blind. But the process cannot be continued indefinitely, for if there are too many layers of planes one layer will rob another of the air on the under side which gives the machine its " lift " when in motion.

In order to scoop in the air when the propeller drives the machine forward, the planes are not only curved, or " cambered," but they are inclined at an angle, the front edge of the planes, known as the " leading edge," being always higher than the rear edge, which is called the " trailing edge." The lifting power of a plane is greatest at its leading edge, even with the narrow planes used in modern machines ; this is because the leading edge of the plane, cutting the air as the machine travels, drives the air downward and away from the trailing edge, so that if the width of the plane were increased the trailing edge would exercise no lifting power at all, and would be so much wasted weight. It is possible to a certain extent to overcome this loss of power at the trailing edge by increasing the curve of the lifting surface from front to rear, so that the trailing edge is much more curved than the leading edge. But to determine just how much the planes should be curved, what should be their depth in relation to their length, and what is the actual effect of the air on curved surfaces, much experiment remains to be undertaken. There are all sorts of eddies and twists in the air when a plane passes through that have yet to be understood before the perfect aeroplane is made, and modern practice is merely a compromise between early design and that which it is hoped to produce. Every month sees some advance in design, and every advance shows that there is more to be learnt.

Lifting power depends on the angle at which the planes are set, and this angle, again, depends on the power available for driving the machine. For instance, if one machine has its planes set at an angle of five degrees, and another its planes at an angle of ten degrees, the latter will rise more quickly than the former ; but it takes more power to drive a plane at ten degrees than to drive one at five degrees. As an example, suppose that a plane 100 feet in length and 2 feet in width is driven through the air at a speed of 40 miles an hour with an angle of one in ten, then that plane will lift 500 pounds, or $2\frac{1}{2}$ pounds per square foot of its surface. If it is set at an angle of one

THE RAIDERS:

A Flight of Seaplanes setting off for a Night Bombing Raid.

in twenty, and driven at the same speed, it will lift only 225 pounds, or 1¼ pounds per square foot. To make the machine lift as much with the greater angle it is necessary to increase the power by nearly half, in order to increase the speed of the plane to about 60 miles an hour. And each increase of power means an increase of weight.

Everybody knows the principle of the propeller, as applied to steamships, so it is unnecessary to describe it. But the aeroplane propeller has been the cause of more difficult problems even than the angle of the planes. The propeller, or "air-screw," as it is more correctly called on "tractor" machines, drives the machine by pushing air behind itself, producing such a pressure from the rear and such a partial vacuum in front as will push the machine forward. Revolving at the rapid rate it does, the propeller is bound to cut several times through the same air, and the number of times that the propeller cuts the same air will vary according to the speed at which the aero-

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AMONG THE CLOUDS.

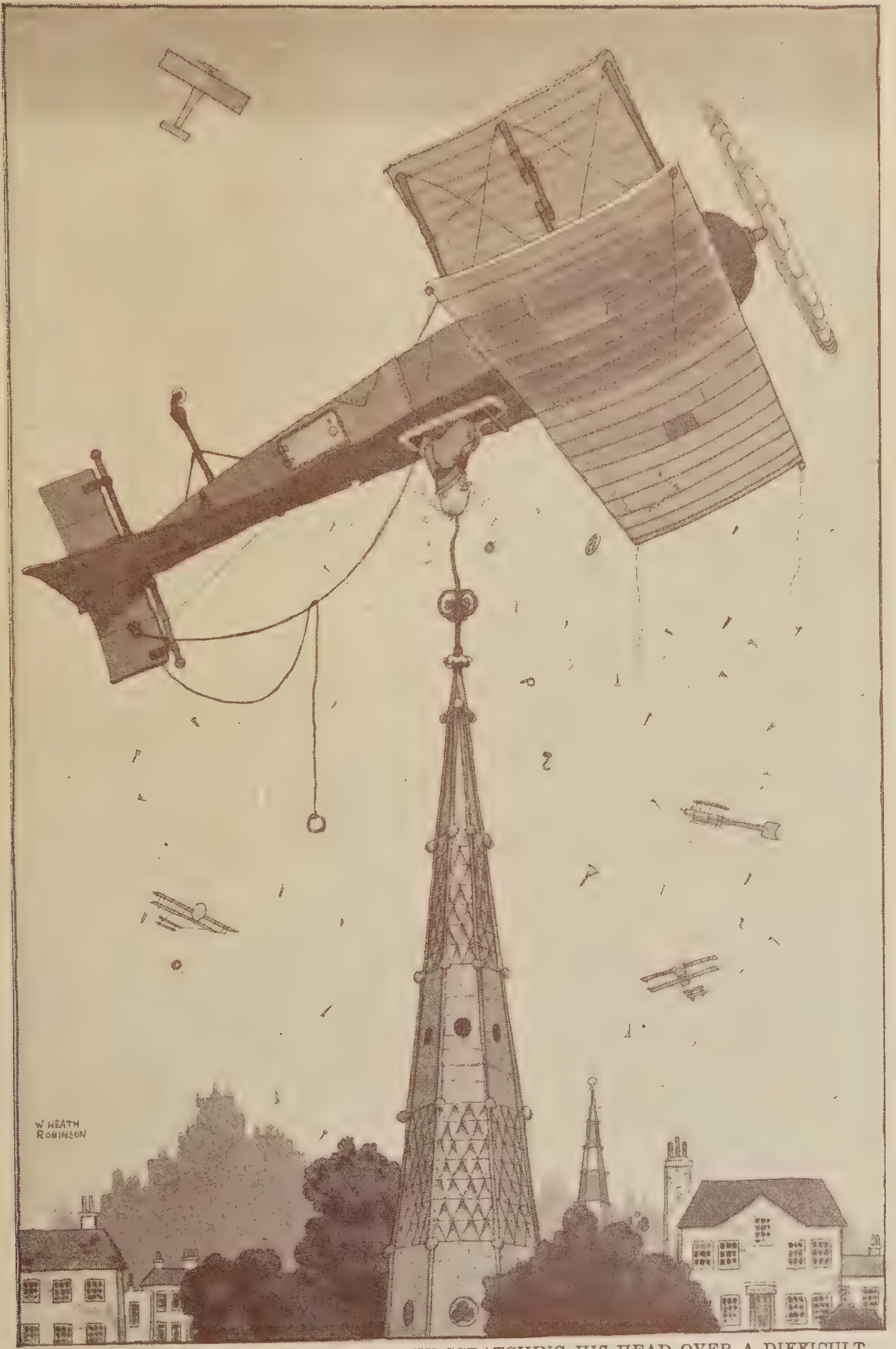
To the fighting airman during the War clouds were of the greatest importance. They screened him from "Archie," but they might also screen an opponent, who would pounce on him unobserved.

plane is travelling. The great problem in making a propeller is the "pitch" of the blades; that is, the twist or curve that is given to the blades to enable them to scoop in the air with their leading edges and to push it backward. All propeller design is a matter of compromise as to which pitch will give the best cutting and pushing effect at all required speeds of the machine.

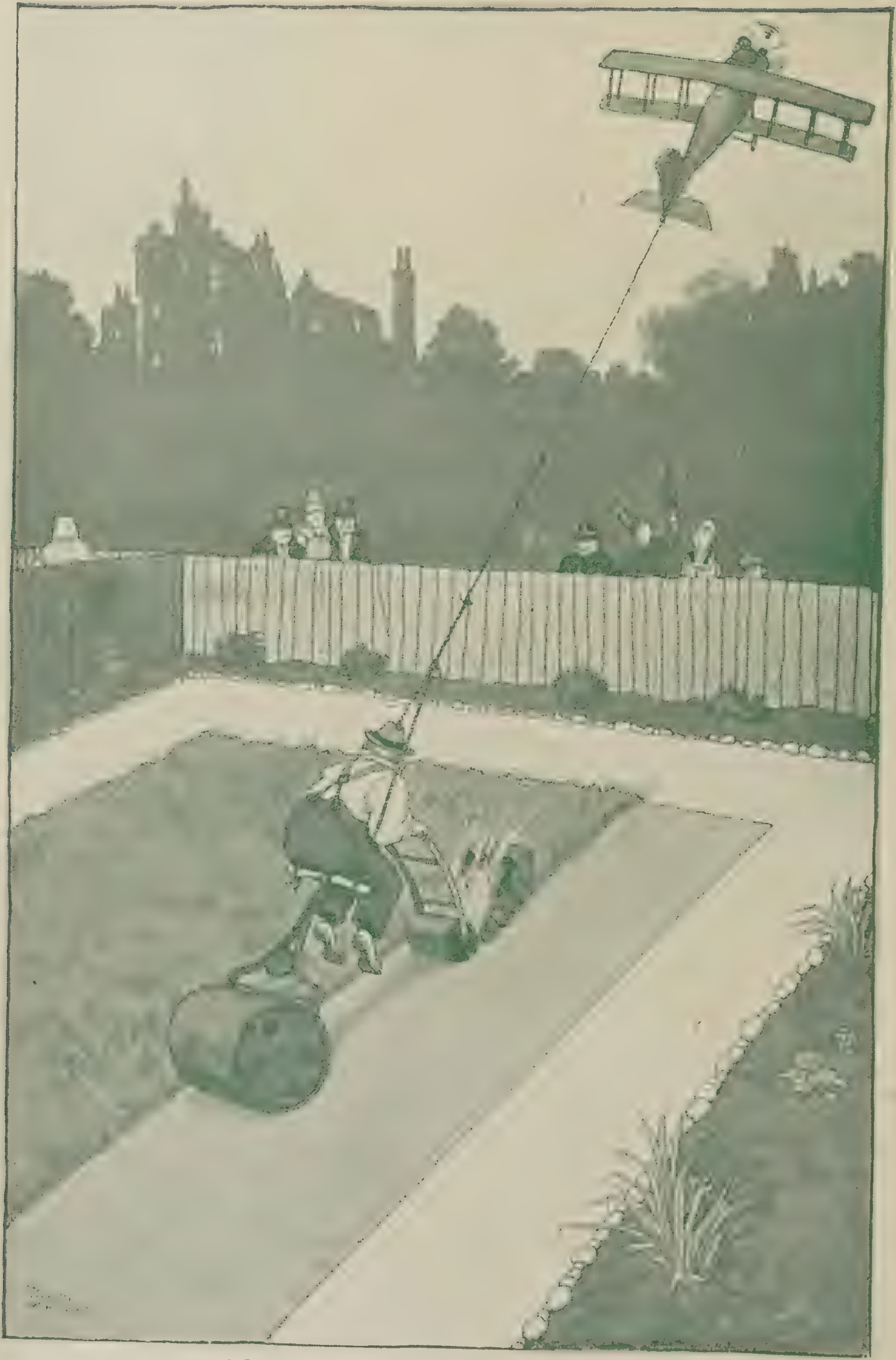
Then there is the matter of steering during flight. Here the problem is complicated by the fact that there is not only steering from side to side to be considered, as in boats and ships, but steering upward and downward as well. In practice these two problems are to a certain extent one; there is a horizontal plane at the tail of the machine, and a vertical plane as well; if the horizontal plane is inclined downward it pushes the tail of the machine up, and the nose is therefore pushed down, while parts of the leading edge of the main planes are hinged, so that they help the work of the horizontal tail plane. Steering to either side is effected by means of the vertical plane at the tail, which works in the same way as the rudder of a ship, and by being inclined either to right or left turns the whole machine accordingly. The pilot uses his steering gear not only to direct the course of his machine but to help maintain its balance in the air.

The greatest problem of all, perhaps, is that of stability, or the means of so constructing a machine that it shall maintain its balance in the air. At first it was thought that by letting the weight hang far below the planes stability would be assured, since the weight would act in the manner of a pendulum and keep the machine right side up, but very little experience was necessary to disprove this. Then tilting the planes, so that the outer ends were higher than the centre ends, was tried; but this proved wasteful of power, since it let the air that should have lifted the machine slip away at the outer edges. The great degree of stability attained during the War is due to the formation of the planes themselves and the construction of the tail of the machine, and these are modified by the necessity for extreme strength in construction. Much yet remains to be done in assuring stability, just as much remains to be done in producing the perfect propeller and the perfect engine, to say nothing of the perfect supporting plane. But when we realize what has been accomplished in the dozen or so years of flight, and with what wonderful rapidity flying has advanced, we are forced to the conclusion that perfection, within human limits, will yet be reached.

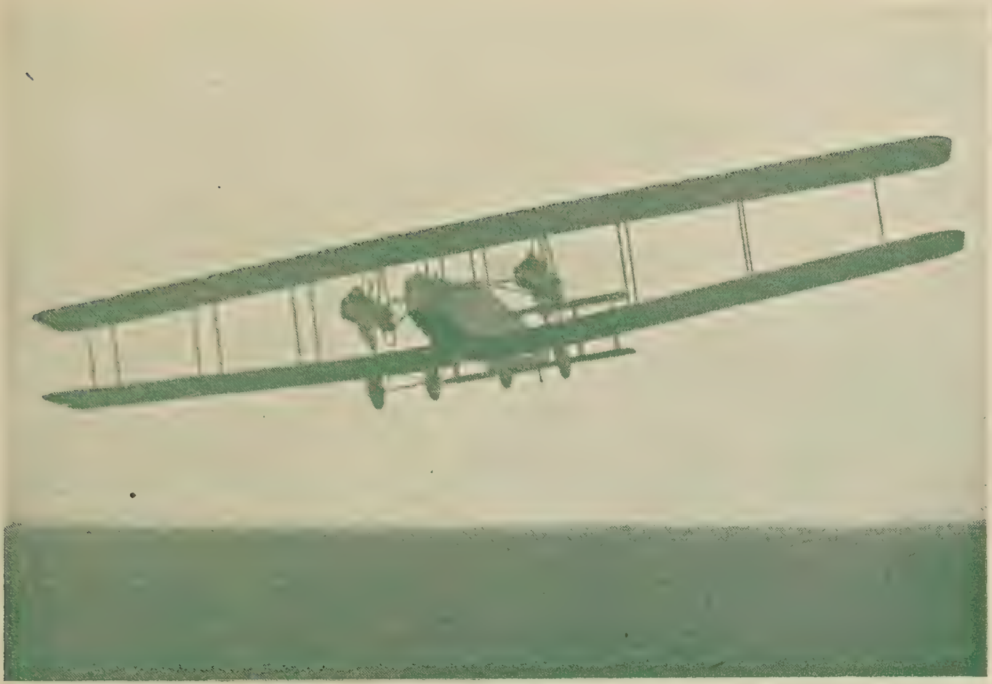
D. S. MANN.



A LOOP-THE-LOOPER IN DEEP THOUGHT SCRATCHING HIS HEAD OVER A DIFFICULT PROBLEM.



A HINT TO THE AIRMAN HOME ON LEAVE.
Give Pater a little help in the Garden.



[Central News.

ONE OF THE LATEST GIANTS.

A Handley Page four-engine machine in flight. It has Rolls-Royce engines of 1,400 horse-power, and is capable of carrying 60 people or a load of six tons.

Liners of the Air

A Peep into the Near Future

SEVERAL firms of aircraft builders have already specialized on machines suitable for passenger-carrying; in England the Handley Page Company build machines capable of carrying loads of five to six tons, in Italy the Caproni Company construct machines of practically similar capacity, and in America the Glenn Curtiss Company, largely engaged in machines for sea work, build flying boats which can take over six tons of load, apart from pilots and fuel. A fourth firm of the kind is the French Caudron Company, which also produces twin-engined giants. In Germany the Zeppelin factory turned from the making of airships to the construction of giant planes, and the Gotha builders, copying the Handley Page of British make, produced a machine somewhat inferior, but still capable of carrying big loads at a good rate of speed.

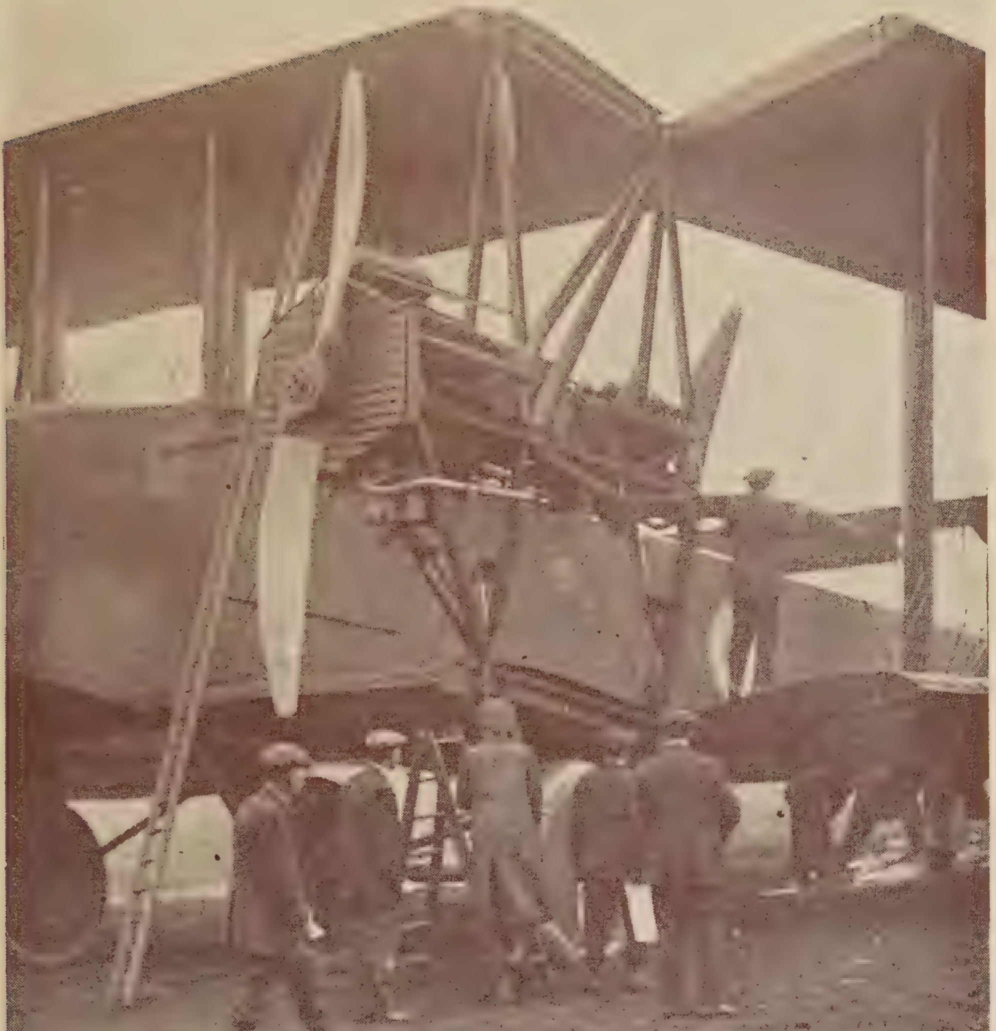
These, more especially the first three, are liners of the air that in a very short time will compete with railway and steamship. It will not be a matter of competition in every case, for there are parts of the world and possible industries which are merely waiting for the aeroplane to open them up. Just as railways created industries and opened up great tracts of country, so it will be the province of the air lines to open up more of the world and to increase work and wealth in every continent.

The following few examples of what the aeroplane can do in this way are given merely to show how useful a feature of civilization air travel must become; they do not exhaust the list of tasks that wait for air lines to accomplish. In each case the route given or the service shown can be followed on the map, when it will be seen that the establishment of air lines will mean as much increase of available territory for the use of Man as did the introduction of steam.

First of all, take the continent of Australia. Away to the west, and almost isolated from the rest of the continent, is the city of Perth, centre and capital of Western Australia, much of which is desert country, and much of which is quite unexplored. On any large-scale map of the territory you may see such records as "Buck's farthest," ending a thin dotted line inward from the coast. These lines indicate the efforts of explorers to penetrate the waterless districts of the interior, and in every case the explorers were turned back through fear of thirst, that terror of new countries. Inland, however, it is

[*Central News*.

READY TO START.
The Handley Page four-engine machine on the ground.



[Central News.

A HANDLEY PAGE BOMBER.

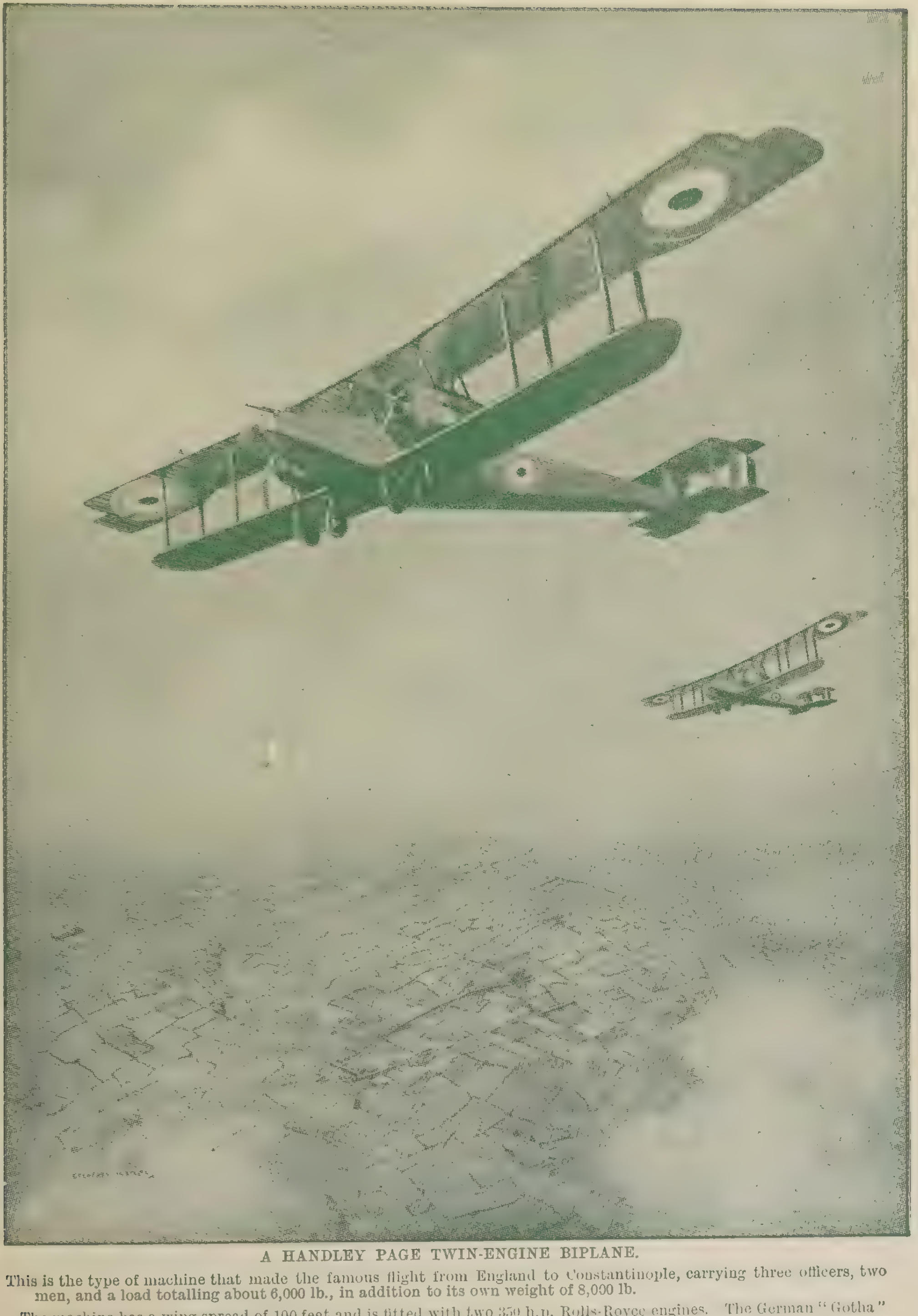
One of the many huge machines that were ready to bomb Berlin had not the Armistice been signed. It has four Rolls-Royce engines, each of 350 horse-power, a total of 1,400. Note how the wings, which have a span of 127 feet, can be folded back to save space in the hangar.

almost certain that there are rich mineral treasures, and yet, until some way of locating them can be devised, it is not worth while to build railways and expend great sums on the chance of the plan paying. Opening up the country can only begin when its mineral resources are proved, so that the company which lays down the track and provides the rolling stock can be certain of some return for its outlay.

Enter the aeroplane, with, in addition to its pilot, a couple of skilled surveyors. In a couple of days the passengers on that aeroplane can ascertain what it took explorers on the ground weeks or months to find out. They can fly four or five hundred miles inland, and return with specimens of mineral ore, together with definite reports on the nature of the country and the existence of water at certain spots which render ground routes possible in certain directions. Assuming that a vein of mineral ore of any kind is found which proves worth working, then a service of half a dozen big aeroplanes can carry to the spot all the machinery necessary, all the men, and all the stores, and can bring back the products of the place. Meanwhile, with the additional population that will come to Western Australia, attracted by the new industry, it becomes worth while to open up a permanent passenger service between Perth, Melbourne, and Sydney, in addition to the air postal service joining up the three cities. And the setting up of intermediate stations between the three cities attracts builders, mechanics, storekeepers, engineers—the one industry attracts many, and in that way the aeroplane creates employment and wealth.

A second route in the same continent is the Transcontinental one, on which an air service for postal work is urgently necessary. From south to north of Australia, apart from the air line, there is only slow and difficult communication, and for the next twenty years or more no railway between the south coast and the north could ever pay, for the cost of maintaining the line would be immense. On the other hand, an air line with half a dozen intermediate stations can bring the southern cities within two days' journey of the northern coast, linking up all Australia with the Malay Archipelago, and bringing Singapore within three days' easy journey. In a general way, there is a clear atmosphere, and advantage can be taken of wind currents in both directions of the journey by travelling at suitable heights. In a very few years Colombo may count itself within two days' journey of any of the Australian cities.

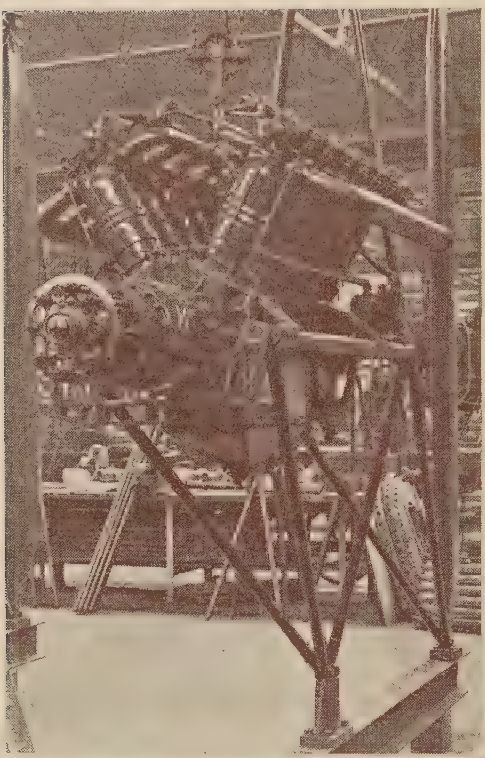
Then, turning to America, there is an immense field for aerial



A HANDLEY PAGE TWIN-ENGINE BIPLANE.

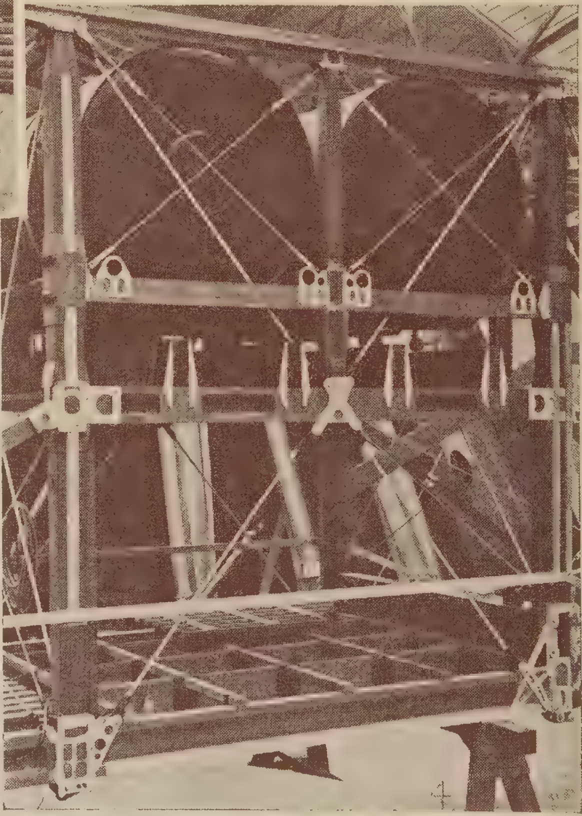
This is the type of machine that made the famous flight from England to Constantinople, carrying three officers, two men, and a load totalling about 6,000 lb., in addition to its own weight of 8,000 lb.

The machine has a wing-spread of 100 feet and is fitted with two 350 h.p. Rolls-Royce engines. The German "Gotha" was to a large extent copied from it. If otherwise unloaded, it will carry twenty-one passengers, but for pleasure and commercial trips it is not usual to carry more than twelve, the surplus room being allotted to passengers' baggage.



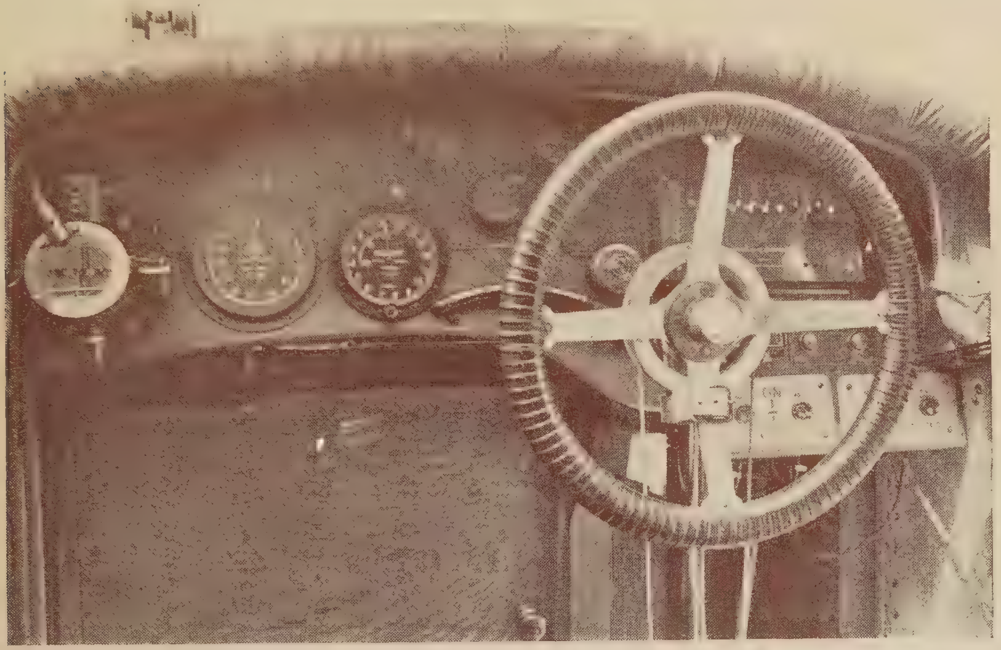
A ROLLS-ROYCE AEROPLANE ENGINE.

services on both sides of and across the Andes range of the Southern continent. The three Republics of the western seaboard, those of Colombia, Peru, and Chile, cannot afford railways to any great extent, for the difficulties of laying rail tracks in the mountain regions are tremendous, and the work would be so costly that the revenues would not be big enough to cover the cost. A study of the map of South America will show that most of the railways of the western coastal area are short lines running inland to the foot of the great mountain range, and ceasing there, the exception being the Transcontinental line that links up Buenos Aires in Argentina with Valparaiso. A north-to-south line from Quito to Valparaiso would link up all these short transverse lines, and would stimulate trade and industry immensely, but the cost of such an undertaking would be so great, and it would traverse so much country that is unprofitable desert, that



THE CENTRE SECTION AND BOMB BAY OF A HANDLEY PAGE BOMBER.
The bombs are released through the squares in the floor.

it could never be made to pay for itself. But an air line is a different matter ; with a northern terminal station at Colon, it would be possible to link up the busy zone of the Panama Canal with Bogota, and thence the line would carry on to Guayaquil, Quito, the nitrate ports of southern Peru and northern Chile, and right down through the fertile areas of Chile itself, ending at Punta Arenas in the extreme south. A branch from this line, striking eastward, would open up Bolivia, and regular communication between the cities of the lower Amazon and the centres of the western coast would be a matter of a day or two days, instead of—as now—two or three weeks.



THE CONTROL WHEEL AND DASHBOARD OF A HANDLEY PAGE.

Industries that would directly benefit at once would be the emerald mines of Colombia, and the various mineral industries of the Andes range. There are veins of gold in the Andes that would not pay the cost of working if rail transport had to come into the scheme, but if air lines were responsible for the transport of men, machinery, and stores, those veins might be made profitable. Similarly, prospecting for all the precious and many of the baser metals might be begun if air lines were available to open up the country without the expense of making railways or roads in the broken, mountainous regions. And

A TWO-ENGINE HANDLEY PAGE WITH FOLDED WINGS.

then would begin the trade that follows on trade; the aeroplanes themselves would bring erecting shops and repair shops; there would be houses to build, clothes and food to buy and sell for the people engaged in the air industry, and cultivation of the land to provide for their needs, so that in a very little time the population of the area fed by the air lines would be doubled or trebled, merely through the introduction of the air service.

Yet another field is that of Central Asia, which would be linked up both with the eastern Chinese coast and with India—and probably with Europe and England as well—by an air line. From London to Japan by the shortest possible route apart from air travel is sixteen days, but by the Transcontinental air line it would come down to three days, allowing for stoppages at intermediate stations. And many men who can save twelve to thirteen days on a journey of this kind will use such a service, since time to them is money. Moreover, since the journey can be accomplished in so short a time, there is not so much "flying stock" needed as is the case with the "rolling stock" of a railway that takes sixteen days on the journey. The railway sleeping saloon takes twelve to fourteen days to earn its passengers' fares across Siberia, but the aeroplane does six journeys in the time, apart from overhauls, and thus earns six times as much, if the fares are the same in both cases. A service twice weekly each way might be maintained at the start, very soon attracting sufficient traffic to call for a daily service.

These may be considered the long lines of the outer lands, lines with which neither railways nor steamships can compete, since their establishment involves far less cost than either rail or steamship lines, and their terminal and intermediate stations cost far less to keep going. Their success is assured from the first run in every case, both as postal services and as passenger lines, for they provide a way of swift travelling that can be secured by no other means. Another prominent example of the kind is the Cape to Cairo line, a journey of about three days by air, in place of the fortnight or so required by rail. Here, probably, will be established the first service of cargo planes, for South Africa deals largely in the precious metals, precious stones, and such light yet valuable goods as ostrich feathers. In the case of precious stones and gold especially, time is literally money, and cargo planes bringing these things up the Cape to Cairo route, either to go on to the great centres of Europe direct or to tranship at Cairo on to the Trans-Mediterranean air line, would save sufficient interest on money to make the line at once a paying proposition.

It is to be noted that every one of these plans is considered with a

[*Central News.*

OFF!

The pilot of the "liner" is just giving orders to remove the blocks from the wheels of the under-carriage.

[By courtesy of Flying, U.S.A.

THE MARTIN "BLUE BIRD."

This handy little machine is in marked contrast to the monsters shown. It is only 18 feet wide, weighs a trifle of 350 lbs., and has a 40 horse-power motor. Its great advantages are that it can start from and land on a country road and will fly 22 miles to the gallon of petrol used. It might well be called the "taxi of the air."

view to the service paying its way, for, no matter how attractive a plan may seem, it must show a return for the capital invested or it is of little use. And in every one of these cases there is reason to say that the service would *pay*, so that capital could be invested in it with a view to a reasonable return, while at the same time the whole world benefits from its industries being brought into more rapid and certain communication with the great centres of civilization. If the nitrate fields of Chile can be reckoned as three days' journey from London instead of five to six weeks, the saving of money to the nitrate companies is sufficient, purely from the business point of view, to justify their establishing an air line to take the place of cable service for messages and steamship traffic for passengers.

Every year, too, thousands of people leave Europe—unless War stops them—in order to visit other continents for holiday or pleasure purposes. Many of these people would be glad to miss the week to three weeks on the sea that lies between them and the countries they wish to visit ; and, with air lines at their service, they can get from the fog of London to the sunshine of the West Indies in three days instead of fourteen, or from Paris to Japan in three days instead of a fortnight to five weeks, which is the time taken by land or sea route. Travelling in comfortable cabins in the air liners, with sleeping berths and restaurant services, they could perform any journey in just as much comfort as by sea or land, and would be able to travel farther and to see more in the time at their disposal than was ever possible under the old conditions. These people, together with the business men to whom a day saved in travelling means the use of a day in profitable work, will keep the cabins of the air liners filled, both going out and returning, from year's end to year's end.

Apart from regular lines, there is the development of private flying on the part of individuals who see in the new means of transport a pleasure beyond that of motoring or sailing; for such there are definite types of machine which, set beside the big air liners, look like dogs compared with elephants. Beside the great Handley Page four-engined machine, with a wing spread of 127 feet and 1,400 horse-power, may be placed such a machine as the "Snipe," with less than 18 feet wing-spread and, for pleasure purposes, an 80 h.p. or even a 60 h.p. engine as motive power. Again, beside the great Curtiss flying boat, carrying 50 passengers and travelling at 80 miles an hour with a crew

THE CRATER OF VESUVIUS VIEWED FROM THE AIR.

This remarkable photograph, reproduced by courtesy of Major Savory, the pilot of the machine, was taken from the Handley Page that made the historic flight to bomb Constantinople.

of five men in addition to its passengers, may be placed the Martin "Blue Bird," which has a wing-spread of 18 feet, a 40 h.p. motor, and is so compact that it can start from and land on an ordinary country road. This little machine will fly 22 miles to the gallon of petrol used so that, in addition to being an ideal pleasure craft, it may rank as one of the "taxi-cabs" of the air, as it will carry two persons at a speed of from seventy to eighty miles an hour.

The development of these small machines, cheap to build and fly, is of great aid to flying as a sport, for they demand, in comparison with the big passenger-carriers, very little storage room, and far less landing area, especially when fitted with low-powered engines and adapted for slow landing speed. At the same time they are ideal vehicles for inland travel; a man in a hurry to get, say, from London to Manchester, might hire one of these small two-seater machines with its pilot, and do the journey in three hours.

One drawback to flying as a sport is the absence of any sense of speed when over 2,000 feet above the earth. Although a machine may be travelling at 150 miles an hour, the only effect is a terrific wind, while, on looking down, the earth seems to slide past slowly and lazily. As one goes higher, the earth seems to move past more slowly still, while, if the air is clear, the horizon recedes as things immediately beneath grow smaller, and all the ground looks flat—it is impossible to trace hills or valleys, except for the heights that stand up prominently on the horizon line, distinct against the sky. It is only when within 500 feet of the ground, or less, that there is any sense of great speed at all, and even then 100 miles an hour in an aeroplane does not seem so fast as 50 miles an hour in an open motor.

One of the principal developments of the sporting side of flying is that of "record-hunting." There are records still to be captured in distance and duration of flight, and the height record, of course, is one that is always capable of being improved, though it is probable that for some years to come 35,000 feet or so will be the limit reached, owing to the intense cold and the difficulty of breathing at great altitudes. Above 20,000 feet the provision of oxygen in cylinders, for the pilot to breathe at all in the thin air, is a necessity; while, in the case of Captain Lang's record of 30,500 feet in January, 1919, the cold froze the supply of fuel to the engine at that altitude, and prevented the machine from going higher. But, as construction is improved, the difficulties of great heights will be overcome, and "record-hunting" as a sport may be expected to last for ever.

CAPRONIS OVER THE DALMATIAN COAST.

SAVING THE GUNS

"I'M sorry," said the Squadron-Commander, "but I'm afraid it's impossible."

The Boy laughed; a hollow, mirthless laugh, that badly served to cover chagrin and disappointment. He had asked so little, but that little meant so much. The chance, the great chance for which he had longed from the day he first set foot behind the firing-line.

"You see, I have myself to consider," the elder man continued, to soothe his junior's ruffled feelings. "Put yourself in my place. All the responsibility is on my shoulders. Day after day we have been losing guns in a most important position. The General is furious. Either his orders are carried through, or"—the Commander smiled dryly—"it will be my head on a charger.

"To carry through a ticklish operation like this needs a man with experience. I don't mean that you are not capable of doing it. I think you are. But suppose you failed? Anything might happen. You might be shot down. You might have engine trouble. These things are unavoidable in war. You might not even be able to find your way.

"Not that I suggest you would fail," he went on, as the Boy was about to protest. "But imagine the hullabaloo there would be. Why had I sent up a youngster like you on a job like this? Why not a more experienced man? No! It's impossible, Hilton. I'm sorry."

"So am I, sir," replied the Boy miserably. "But, anyway, if you don't mind I'll hang on, in—in case anything happens, and you might want me."

He saluted smartly and went out.

The Commander turned again to the large scale map on his desk. Marked off neatly in squares, it showed the smallest turning and field in the locality. His trained eye roamed from point to point, taking in fields and villages, towns and cities, over an area of twenty miles. Particularly his attention was devoted to a large wood marked between three and four miles behind the German trenches.

Hidden somewhere in the depths of that wood lay the giant howitzer that had been destroying the guns in the British positions. At first it had been considered an every-day event of the War. But when great "nine point two's" and "fifteen inchers," carefully hidden in quiet corners, had been wrecked immediately they had been put up, the General Staff had lost their heads. In desperation they had turned to the Air Force, as if determined to make them the scapegoats. To the Squadron-Commander the discovery or non-discovery of that gun meant promotion or disgrace—and he knew it.

Wearily he examined for the twentieth time a handful of photographs his reconnaissance craft had brought in during the past few days; compared one with another, and carefully marked off a position in the wood. Then he rang for his orderly.

"Tell Mr. Langton I wish to see him immediately," he said.

At that moment the telephone at his elbow rang noisily. With a grimace he put the receiver to his ear. "Hullo! Yes! Yes, sir, speaking!"

From the other end came the gruff, rumbling tones of the General. He made no attempt at beating about the bush. His language was choleric. Why hadn't that gun been silenced? Hadn't his orders been distinct?

The Commander took it all with a wry smile. Involuntarily

"A MINUTE LATER THE MACHINE WAS CLIMBING FAR ABOVE THE AERODROME, TO DISAPPEAR EVENTUALLY IN THE DIRECTION OF THE FIRING-LINE."

he wondered why "brass-hats," who must, of necessity, have once been young themselves, should always take needless opportunities of abusing youth serving in their command.

Langton came in, and he motioned him to a chair. As in a dream the Commander was aware of a long stream of orders flowing through the wire; to all of which he replied in sharp monosyllables. Then silence. He replaced the receiver with a jerk.

The movement was not lost on Langton. "The old man at it again?" he inquired briefly.

The Commander nodded. Words were never wasted between these two. They had served together from the early stages of the War, had been in many a tight corner together, and thoroughly understood each other's methods.

"It's that confounded howitzer again," said the S.-C. wearily. "That's why I sent for you. We simply must put an end to this business. It's becoming unbearable."

He pulled the map towards him and for ten minutes they were hard at it discussing ways and means; their language mostly in the queer vernacular of the Air Force. This position was EX. 2. H.; that town, with the two main roads and the railway junction E.W. 3. K. Langton was to take a "camel" and "sit over" the position until he had "spotted" the gun; then either to "lay his eggs," or, in the eventuality of "getting pipped" to wireless the position back to our heavy guns. At the end of the conversation Langton knew the supposed position of the howitzer to an inch.

After he had gone, with a parting admonition "to destroy the gun at any price," the Commander was again left alone with his thoughts, and they none of the pleasantest. His eye wandered round the room. Through the open window he could see Langton's machine drawn on to the aerodrome. Mechanics were hurrying to and fro, filling the petrol tanks, fixing the machine-gun, and fitting bombs into the long rack below the body. The engine started off with a roar. Then Langton himself appeared on the scene, in leather coat and cap, with hideous goggles over his eyes.

Climbing into the machine, he nodded briefly to the waiting mechanics. The blocks were jumped from beneath the wheels; round went her tail, and a minute later she was climbing far above the aerodrome, to disappear eventually in the direction of the firing line.

Then that phrase of the Boy's came into his brain, "in case anything happens." Of course nothing would happen. The idea was absurd. Langton was one of his best pilots. He had never failed before. Why should he now? Spotting a gun, to a man with Langton's experience, was mere child's play. Thank Heaven, within thirty minutes this tension would be over. The gun would be discovered; there would be a certain decoration for Langton and badly-needed congratulations for himself.

Already he pictured the scene; the portly, red-faced General, with his pompous, condescending manner, the long string of medals on his left breast slowly expanding to their fullest extent—a sure sign that he was about to speak.

The S.-C. laughed softly at the thought of the ridiculous figure his superior would cut. Then he would clear his throat! "Mr. Hillier, a very good day's work. Allow me to congratulate you. And carry my congratulations to the officers and men under your command. Tell them I—ahem—I consider they have done splendidly—yes, splendidly."

The General was nothing if not painfully red-tapish.

"If anything should happen." Bother the Boy! He was getting on his nerves. Why couldn't he get him out of his head this morning? He remembered his first arrival from home, a pink-and-white subaltern with a crop of curling fair hair, and dancing blue eyes that betrayed more than a touch of mischief. Only three months out from Sandhurst, the Boy had not yet had time to shake off a somewhat gawkish school-time air and a strange shyness.

In age he looked little more than sixteen, and friends in neighbouring units had not been slow to comment on the fact. The Commander had grown somewhat tired of their constant innuendoes as to kidnapping and other disreputable hobbies.

But, though so young, the Boy looked every inch a soldier. His lithe, supple body, back-thrown head and springy step betrayed his breeding. His father, his grandfather, and their forefathers before them had all been soldiers. His father, Colonel Hilton, V.C., had long retired from active service; and when the great call came, desperately though he tried, he could give no more than his only son.

His parting advice to the Boy had been brief and to the point. "Remember, my boy, you are a Hilton; you bear an honoured name. See that you don't disgrace it."

The advice had sunk deep into the Boy's heart. At Sandhurst he had worked like a nigger; and so successful had been his efforts that he had passed out three months ahead of his time. Before his nineteenth birthday he had arrived at the war area a fully fledged pilot.

Naturally his extreme youth had caused him to be "ragged" considerably. But the Boy had taken all in good part. In time the baiters had grown tired of their amusement; and now it was generally agreed in the mess that the Boy was a thundering good fellow.

His capabilities as an airman had surprised even the Squadron-Commander himself. The latter watched his progress with no slight interest, for his trained eye realized from the first that here was a pilot above the average. At every opportunity he had given the Boy a chance with the more special "stunts." He was keen; and that in the Commander's eyes was a priceless virtue. Certainly none of these expeditions had been affairs of extreme importance. But on each occasion the Boy had carried the work through cleanly and without mistake, and now——

Should Langton fail—he hoped to Heaven he wouldn't—but anyhow the Boy should have the first refusal of the job. And——

His trained ear caught the hiss and plunge of the wireless key in the adjoining room. Evidently Langton was already in communication.

He strolled to the wireless set. The operator was busy taking down a message and did not look up until he came to the end of the page, which he tore off and handed to the S.-C. without a word.

The message was in brief, jerky sentences, interrupted here and there with long pauses, as though the operator were too busy with other affairs.

The S.-C. slowly read it through.

"10.20 a.m.—5,000 feet—slight mist over the trenches—clearing towards the sea—little activity—some enemy shelling E.H.3.B., evidently heavy guns. 10.25 a.m.—8,000 feet—over shrapnel—heavy bombardment—shells bursting very close. Moving up——"

Here the message broke off for fully five minutes. The S.-C. hurried anxiously to the window. No! there he was, a tiny black speck on the distant horizon, climbing higher and higher above the clouds.

Then, *buzz! buzz! birr! buzz! buzz!* The wireless instrument was again ticking out that strange message from the clouds.

"10.32—12,000 feet—crossed the lines—enemy's country fairly inactive, slight movement in reserve trenches. A-A bombardment less severe—section E.H.8.F. roads congested with reinforcements marching up to front line—train, locomotive, five coaches, travelling west between S—— and M——. Shall I go down and have a go at them?"

"Wants to know if he shall go down and have a go at the enemy reinforcements E.K.2, sir," remarked the operator without looking up.

"Certainly not," replied the S.-C. sharply. "Tell him to keep straight on to his objective."

Rapidly the operator tapped out the message. For a few moments the room was uncannily silent. Then, suddenly the instrument was rattling again.

"10.42 a.m.—12,000 feet—over L—— wood. Nothing suspicious. Going down to investigate—Terrific bombardment."

Then a last feverish hiss.

"Over gun. Exact position you plotted. Gun to left of wood by main road."

The Commander gave a slight grunt of satisfaction.

"Gun covered with planking, grass, tree-branches, and gravel," the instrument ticked on. "Think I can bomb—going to——"

Suddenly the ticking stopped. The operator glanced up with an unpleasant air of understanding. The S.-C.'s face grew tense.

There, in the far distance, its red, white and blue rings showing plainly in the bright sunlight, the craft staggered, recovered, and staggered again. Then down it went, wing over wing, round and round, faster and faster.

Soon a burst of flame showed at the nose. Down she went, head-foremost, and plunged, far out of sight, into the German lines.

* * * * *

The Boy had watched the flight from the time Langton left the aerodrome. An indefinable instinct had suggested that, after all, something would happen and he would be called for. Almost before the other was out of sight he had given orders for his machine to be got ready and had slipped on his flying gear. And now, as he watched the uncontrollable machine dive headlong to the earth, he could scarcely repress an unhealthy feeling of joy. Poor old Langton! Of course he was sorry for him; desperately sorry. He had been one of the best. He would miss him badly. But, after all, it meant a great chance. It was only natural——

Breathlessly he hurried into the Commander's office. Would it be Yes or No? He had half promised, and there was no one else at hand.

The Commander was staring gloomily out of the window, but he wheeled as the Boy dashed in.

"It's all right, Hilton," he said quickly. "I'm going to give you the chance. And good luck to you!"

"Thank you, sir," replied the Boy gratefully. "I don't know how I can thank you sufficiently."

"By justifying my faith in you," replied the elder man quietly. "Be off; there's no time to lose."

The Boy needed no second command. In little more than a minute he had dashed across the aerodrome, had his engine started, and was climbing into the clouds.

What a glorious day, to be sure! The blood tingled through his veins; he felt a mad desire to shout at the blue sky and the racing clouds and make them the confidants of his good fortune. Never had his machine behaved better. On the instant she answered to his every movement. Now he had her heeling over in a graceful bank—almost on the wing-tip. The next minute, with nose down, he was cleaving the void that lay beneath; another minute and he was climbing up against the sunlit sky.

Over there, somewhere in the grey mist behind the firing lines, lay the giant gun he was to destroy. Destroy it he would or die in the attempt. For this was his chance—his chance—his chance! The words kept running through his head. How pleased they would be over there at home, or——they would understand *that* equally well.

"*Whouf! Scrunch!*" A burst of black and red smoke bit into the sky fifty yards beneath his tail; another, and another, and another, in all directions. But with a smile he dived through the middle of them, out of range.

Below, the country grew more open. There were fewer grey-smudged towers and blue-grey roadways; more green and golden fields and pasture lands; and a comic railway that zig-zagged in all

"DOWN AND DOWN SHE WENT, TWISTING AND TURNING."

directions, like the topsy-turvy at a summer exhibition. And there, a little off the main road, lay the wood he had come to find.

The Boy's heart leapt within him. He seized his glasses and searched the wood from end to end. But nothing could he discern, not a break in the regular green surface of the tree tops. Perhaps there was some mistake.

But no! It was distinctly marked on his map and there could be no possible doubt. For there were the two main roads, one north and south, the other east and west. And there in the background lay the straggling village with the spired church.

He must go lower. Perhaps he would discover something then.

He put her nose down, lower and lower. The wind whistled past his ears; faster and faster grew the pace. The speed was exhilarating. Lower and lower. At last he had sighted the position. Carefully screened in the wood, about fifty yards off the main road, the sun revealed the long muzzle of a gun. The Boy was satisfied.

He felt for his bomb-release. In another moment he would be well in line. Then he ran right into it. The burst took him unawares. The machine shook from stem to stern. The Boy could hear the ugly rattle of shrapnel on the wings; the flames and the charge seemed to strike him right in the face. He was conscious of a sudden excruciating pain in his left side. As suddenly the commotion ceased.

The uncontrolled machine plunged into a break-neck dive, and the Boy lay huddled over his joy-stick. Down and down she went, twisting and turning; then the rush of upward air brought him round. His whole body seemed numbed with agony; his left arm hung uselessly by his side. In some mysterious fashion the noise and the smoke had all died away. Almost mechanically—by unconsciously superb airmanship—he pulled the machine out, and found himself within a thousand feet of the gun.

The sight of the latter was electrifying. With a flash he recollected the object of his flight and seized the bomb-release. Down went a bomb, hopelessly wide of the mark. The Boy groaned. Another and another. A flash and a roar, that could be heard even above the incessant clatter of his engine, and he realized that his mission was accomplished. Then, before the astonished Germans had time to recover, he turned and made off in the direction of home.

After that the flight became one long, indistinct blur. With his uninjured hand he could feel the thick blood clotting his side. More shrapnel; more narrow shaves. Somehow or other, he could not remember distinctly how, he was climbing rapidly upwards. And after that he must have fainted two or three times.

Later, he was conscious of a continuous rattle of rifle bullets, shells and "Archies" as he almost skimmed the enemy trenches and landed in the first large field he sighted on the British side of the lines. An indistinct murmur of many voices, and no more——

Until he found himself in a white-covered bed in a long hospital ward, a bluff army doctor congratulating him on his lucky escape.

* * * * *

Late that night the Squadron-Commander sat in his office, feeling particularly satisfied. It had been a great day. The Boy had altogether justified his faith. The General had sent an aide along with congratulations. The Wing-Commander was also pleased. Promotion loomed in the near future. What more could a man want?

He turned to the Boy's official report, brought in ten minutes before by a motor despatch rider from the Hospital. He must get it off to the General without delay.

Running through the closely-written lines of shaky handwriting and skipping the unnecessary official preliminaries, he came to the passage: "I was hit by shrapnel, and must have fainted, for when I came to I found myself at an altitude of only 2,500 feet, and continued my descent at a rate of well over 100 miles an hour. At about 1,000 feet I loosed my bombs, the third getting the gun position, which went up with a roar and a sheet of flame. The whole way down I was under fire; two anti-aircraft in the wood, guns from the forts on either side, rifle-fire, machine-guns, and most weird of all, great bunches of what looked like green rockets, but I think they were flaming bullets. My chief impressions were the great speed, the flaming bullets streaking by, the incessant rattle of the machine-gun and rifle-fire, and one or two shells bursting close by, knocking my machine all sideways and nearly deafening me. . . . My eyes must have been sticking out of my head like a shrimp's. I banked first on one wing-tip and then on the other, now slipping outwards, and now up and now down. . . . I then went over German trenches filled with soldiers, and was fired on by machine-guns, rifles, and small field guns, in or out of range!"

The C.O. was awfully braced.

And he gave evidence of his exhilaration by adding a brief note on the corner of the report sheet: "This officer has served consistently well during the whole time he has been under my command. I wish to recommend him strongly for the D.S.O."

EDGAR MIDDLETON.

A KITE BALLOON ON THE WESTERN FRONT.

[Canadian War Records.

[French Official.

FORT VAUX.

The scene of so much fighting during the long battles before Verdun, as seen from an aeroplane.

Learning to Fly

AS many of the older lads who read this volume will doubtless have made up their minds to be pilots, a few hints on this subject may be welcome, even though some years may have to elapse before their value can be put to the test of actual experience.

Whether a pupil will make a good air pilot or not is a question impossible to decide in advance. Many things have to be taken into consideration. The baby boy or girl first learning to walk finds the earth a most wonderful—and hurtful—place; later, as the years pass, it becomes almost wearisome with its monotony.

But when any novel sensation is experienced, there is the same childish fear and wonderment at the start. Take for example such simple experiences as learning to ride a horse, to drive a motor-car, or to swim, particularly the last-named. The horror and the fright on first getting out of one's depth; the indefinable terror of the still, placid water! Yet some will boast that they could swim after their first lesson. Others—less daring perhaps—keep on week after week, month after month, even year after year, and sometimes never succeed. It is largely a matter of temperament, and temperament is—well, just what a boy knows of his own self and capabilities.

Learning to fly is like learning to swim. It is not given to everyone to swim, neither is it possible for all to become airmen.

The air is a wonderful region. Like the sea, it is full of strange terrors and happenings. A boy can never realize how it will affect him until he has personally experienced the sensation. Twenty minutes aloft, strung up between earth and sky, with the wind howling past, and the never-ceasing throb of the engine in his ears, will teach him more than all the books that were ever written. But, as in every other walk of life, there are certain qualities that will either make or mar the would-be airman.

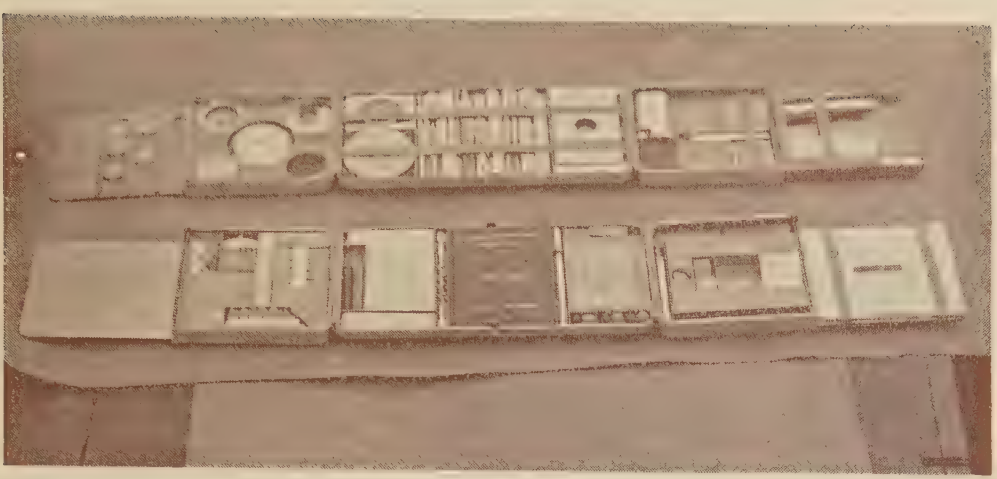
First comes the matter of health. Rushing headlong through the air with more than the speed of an express train; racing through the clouds, thousands of feet above the peaks of mountains; diving down thousands of feet at a time, at two hundred miles an hour, puts the heart, the nerves, and the lungs under a very great strain. Primarily then, the boy who wishes to be an airman must lead a clean life and be fond of the open air.

Then there is the matter of height. The space allotted to the pilot for his seat, his instruments, and his controls in an ordinary aeroplane, is extremely limited. His position is similar to that of sitting in a narrow chair with his legs stretched out in front. At his feet is the steering-bar; between his legs the control stick. Imagine then, if he be too tall, how cramped he will be; and if too short, how difficult it will be to keep his feet comfortably on the steering-bar. Many accidents have occurred through this peculiarity. Only a short while ago a beginner—a very short youth—at a well-known aerodrome suddenly missed his bar and came crashing down, over three thousand feet, to earth. Luckily he escaped unhurt. But he never flew again.

When one is flying at a height the earth is barely distinguishable, or, at the best, it appears to be just one huge, flat plane, with here and there a railway, a river, or a road. Good eyesight then is essential.

The motion experienced in flying, particularly on bad weather days, is not unlike that on a ship at sea. Therefore the pilot-to-be, if he has a weak stomach, may experience in a small machine all the usual uncomfortable sensations of sea-sickness, and perhaps rather more.

In weight he must not be too much on the heavy side. An aeroplane has only a limited lifting capacity. It has to carry an extremely heavy engine; sometimes several passengers; in Wartime, bombs, in-



AN AIRMAN'S OUTFIT.

struments, machine-gun or guns, ammunition, and spare petrol—which does not leave much for the pilot and the observer.

The would-be pilot's heart, too, must be strong. The most

[Illustrations Bureau.

A FEW ODDMENTS.

famous doctors of Europe are agreed that the sudden ascent and descent through various altitudes greatly affects this organ.

But more important than all are nerve and will-power. Flying has a curious effect on a man. The strain on the nerves at every flight is enormous; but it is not generally felt at the time. Only after months of flying does such strain make itself apparent. This, however—quite apart from war-flying, with the additional strain of being continually under shell-fire—rapidly puts an end to the "flying life" of the average pilot.

The term "flying life" needs explanation. It is the period during which a man can fly a machine in the air with the same ease and comfort that he would experience in the safety of *terra-firma.* Suddenly will come a day when he discovers that he is filled with terror at the mere thought of flying; that he dare not attempt any of those little tricks and "stunts" upon which he formerly prided himself. "Flying life" under normal conditions varies from three to five years; under war conditions, often only from three to nine months. After a long rest, however, a pilot can usually fly again as well as ever.

However strong physically, the pilot-to-be will find that this stands him in less stead than will-power. Cases are continually occurring of pilots who have been mortally wounded in mid-air and yet have made their base again. One of the most striking of these experiences came to a young pilot in the summer of 1916. Shortly after dawn he was returning from a long reconnaissance flight over the enemy's country. When still some twenty miles on the other side of the lines, a shrapnel shell caught the side of his aeroplane and shattered his left thigh. Overcome with loss of blood, he fainted and the machine plunged headlong down, over five thousand feet. The rush of upward air brought the pilot round. With a superhuman effort, he pulled his aeroplane out of the nose-dive and carried on. Again he fainted; and again; but each time he recovered. His observer, seeing the agonized condition he was in, hastily scrawled a message on a piece of paper and passed it to him. The message read, "Don't mind landing here and being taken prisoner if it will save your life."

But this was far from being the pilot's intention. Shaking his head vehemently, he nodded in the direction of their base. Twice again he fainted and recovered. Then they came to the firing-line. High

"ALL HOME:"
Sunset at a British Aerodrome.

into the heavens he climbed to avoid the bursting shrapnel, and eventually made a graceful landing in his own aerodrome. A fortnight later this very gallant pilot died of septic poisoning.

A word or two with regard to a man's personal qualifications. In the first few flights aloft, either as a passenger or when piloting the machine himself, these will manifest themselves immediately.

[*Illustrations Bureau.*

AN UNEXPECTED CALLER.

This machine got into difficulties and landed on the roof of a house at Twickenham. The pilot escaped unhurt.

A good pilot is like a good bowler or a good poet—born and not made. Flying is a gift. He will soon discover whether or not he is possessed of that uncanny sixth sense of intuition; whether or not he is ready to the second for the unexpected " side-slip," " nose-dive," or " tail-slide " ; whether the air holds terrors unimaginable, or merely provides a series of attractive sensations.

A first trip into the air is more of an ordeal than the majority of people imagine, with a good many varied and rather alarming sensations. First there is the never-ending roar of the engine, with the hardly reassuring vibration of every portion of the machine. With a loud roar she rushes across the ground at a speed of from forty to sixty miles an hour; then suddenly the roar decreases, and, almost without effort, the machine is climbing into space. The feeling is not unlike that experienced in "taking" a hedge, or a ditch, on a horse. The wind howls past the ears with a pandemonium of noise. Below, the country stretches farther and farther on every hand; dim and indistinct become the objects on the surface, until it seems a tiny toy-like affair with blurs of houses, ribbon-like roads, railways, and rivers. Then the machine begins to rock, dive and plunge as she gets into the "bumps"—patches of rarefied air—until, with a last graceful effort, she is speeding through the clouds over land and river, city and village.

That first flight is merely the preliminary to the flying education. It is always made by the pupil as an ordinary passenger, and is made use of, more often than not, to test his nerve.

Unless a man enters the Royal Air Force his training will cost him a considerable sum. The fee includes, apart from the ordinary flying course, complete tuition in the detailed rigging of an aeroplane, the dynamics of flight, engine-testing, "tuning up," and the practical construction of the many and various components of a machine. In the Service he will also learn gunnery, map-reading and wireless telegraphy.

It is needless to state that the Service method of training differs greatly from that of civilian firms. The would-be war pilot may at first have been trained at one of the latter establishments, but he will always finish his education in a Service school.

And in the Service another difficulty presents itself. There are two distinct and different branches of flying—observation and pilotage. The former officer is really in charge of the aeroplane to-day.

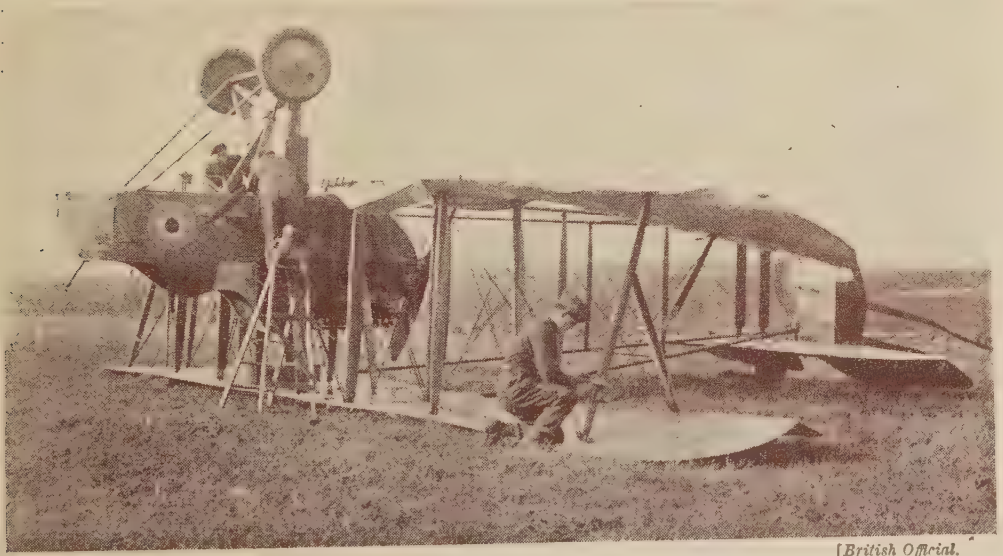
Let us suppose a machine has been sent up on a reconnaissance flight. The pilot has his hands full in manœuvring the machine; the observer must direct the course over the specified points, or area, which his instructions have told him to have under observation. A similar position occurs in aerial combats. Though many of the later types of fighting craft have only accommodation for a pilot, it is much more effective to have a craft manned both by pilot and observer, for the former can manœuvre the machine while the latter fires the gun. The same condition applies to photography and to the direction of artillery fire.

The would-be pilot, as has already been explained, is taken first for a passenger trip. After that there is no fixed rule, the method of training and the time required depending very largely upon the individual. There follow several flights in machines with two sets of controls, one of which is manipulated by the instructor and the other by the pupil; a series of landing practices; and the pupil is then ready to fly alone.

The first thing he must gain is air experience—grow accustomed to being in the air. After that, the matter lies in the hands of the instructor, whose business it is to teach him confidence not only in himself but in his machine. The most ready pupils are those with light hands; particularly those who ride well.

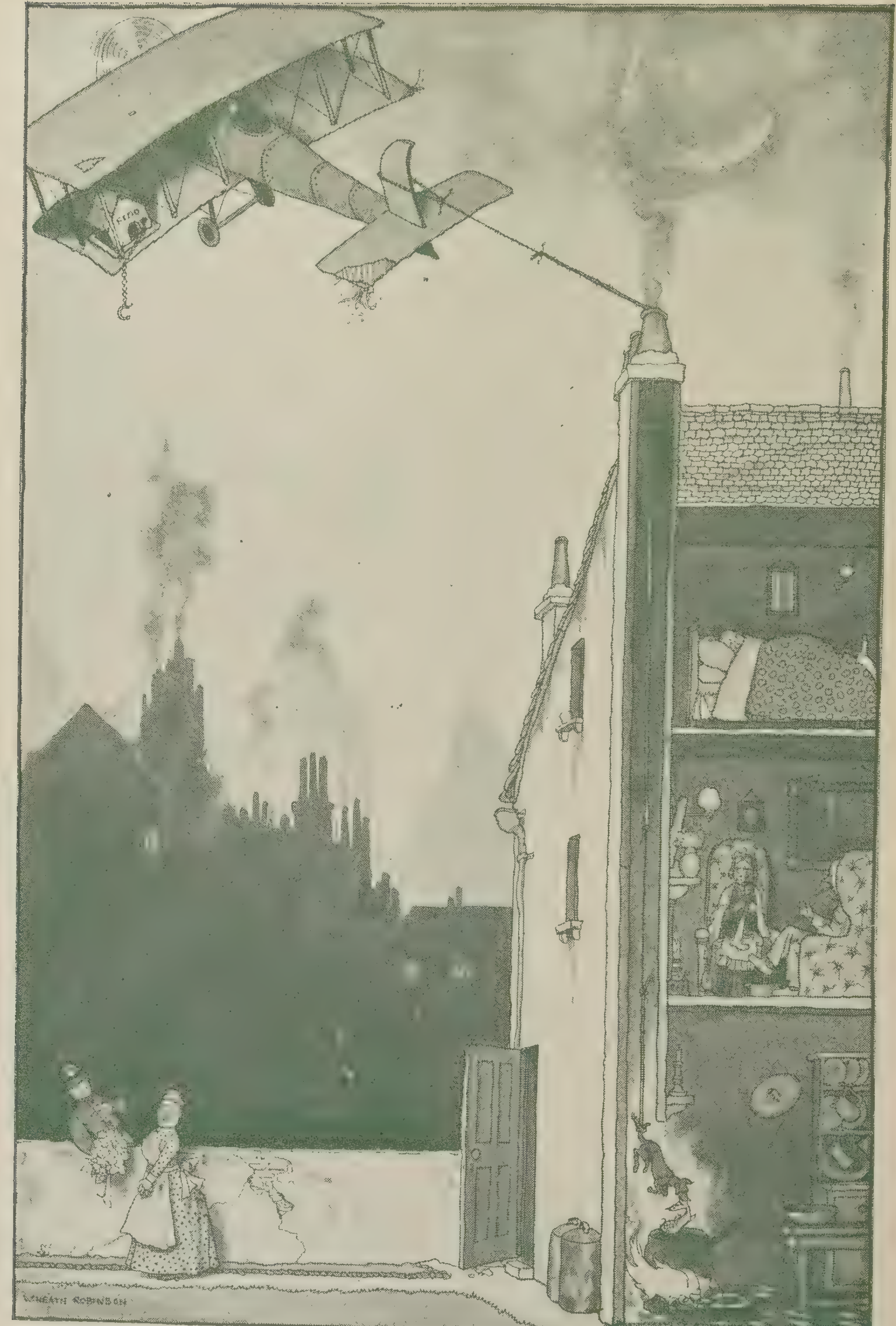
From the first few flights the pupil graduates into circuit trips, right and left hand turns, and finally, if at a civilian establishment, into taking his "flying ticket." Much has yet to be learnt, however, before the pupil becomes an efficient war airman.

EDGAR MIDDLETON.



[British Official.

THIS MACHINE WAS TURNED COMPLETELY OVER DURING A GALE AND FELL IN AN INVERTED POSITION.



AN ABANDONED YOUNG PILOT APPROPRIATING SOMEBODY ELSE'S RATIONS.

A HANDLEY PAGE BOMBING MACHINE IN FLIGHT.

Some Well-Known Types of Aeroplanes

TO attempt a description of every type of aeroplane would take the whole of this book. All that can be done is to indicate roughly the general lines of aircraft of to-day.

Anyone who saw the exhibition flights made between 1909 and 1912 will remember the monoplane form of aircraft, with a single wing on each side of the body. It was a graceful-looking craft, much more so than the majority of biplanes which sail the skies to-day, and even now it is not to be despised for work in which only light weights have to be carried. The most famous monoplane was one of the first—that of Blériot, in which on July 25, 1909, Blériot himself achieved the first crossing of the English Channel by air. This monoplane was driven by a 25 horse-power Anzani engine, and, when we remember that 80 or 90 horse-power is considered low for the aeroplanes of to-day, it will be evident that change in design to support the greater strains was necessary. It was in a Blériot, too, that Pegoud first amazed the world with his upside-down flying.

Biplanes, of which to-day one sees at least ten to every monoplane, are many, and it is difficult to pick out representative types. Among the best known in this country are the Bristol, the Farman, the Handley Page, the Martinsyde, the De Havillands, and, for sea work, the Short, and the Sopwith Scout (see illustrations on pp. 16–17). When any of these are flying at a good height, it is difficult to distinguish between them, except in the case of the huge Handley Page, with its two or four engines, long body, and box-like tail.

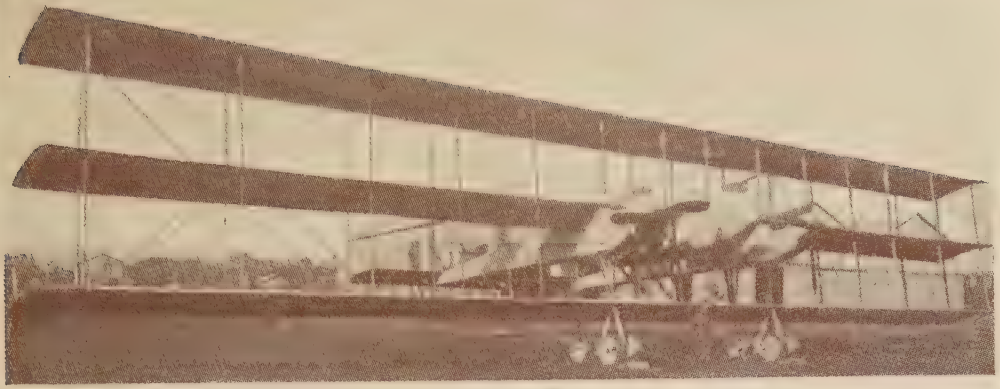
Most of the daylight air raids on Rhine towns were carried out by De Havilland 10s ("D.H.'s"), twin-engined machines with a speed of 123 miles per hour, capable of climbing 5,000 feet in little more than five minutes, or 10,000 feet in 12½ minutes, and carrying a weight of nearly 1½ tons.

The Bristol is a neat-looking, blunt-nosed machine, a single-seater, with a speed ranging up to 100 miles an hour and an 80 horse-power Gnome engine. The Farman biplane is of the "pusher" type—that is, it has the propeller *behind* the planes, pushing the machine from behind, instead of, as is more common, in front of the machine and pulling. It is a small, very fast machine, used principally for scouting purposes. The Martinsyde, one of the strongest machines made, is a two-seater, with engines up to 160 h.p.

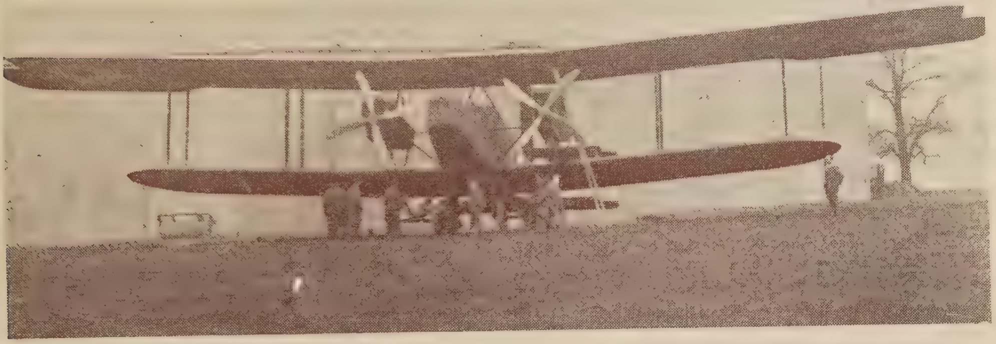
The Short seaplanes are of varying types, rather slower in flight than the average land machine; they are to be distinguished by the floats underneath the body that take the place of wheels on the land craft. A recent modification in the design of seaplanes consists in making the body itself act as a float, so that when not flying the whole machine rests on the water. Most American machines, such as the Benoist, the Burgess-Dunne, and the Curtiss, are built in this form, and Americans have given them the general and appropriate name of "Flying Boats." (See illustrations on p. 103.)

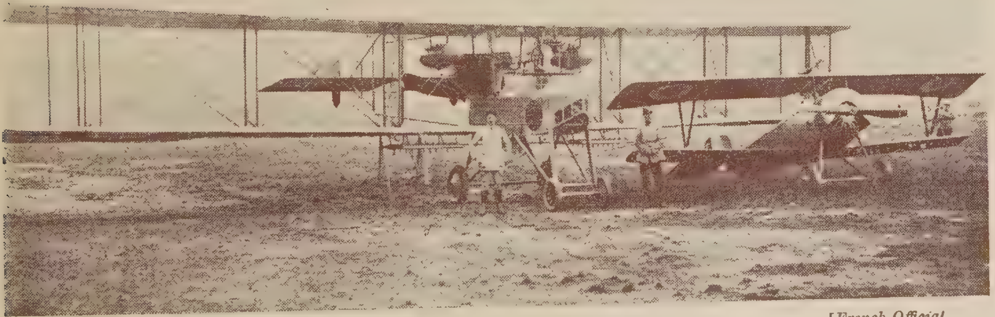
The Sopwith Scout is one of the most successful of British seaplane designs. Its speed ranges up to over 100 miles per hour with a 100 h.p. Gnome engine. For a time a 150 h.p. "pusher" type Sopwith biplane was made, designed as a gun-carrier.

Among the big machines, the Handley Page so far holds most of the records. It is a huge biplane, with either two or four engines, each driving a separate propeller, and each of 350 horse-



[Reproduced from "Flying."

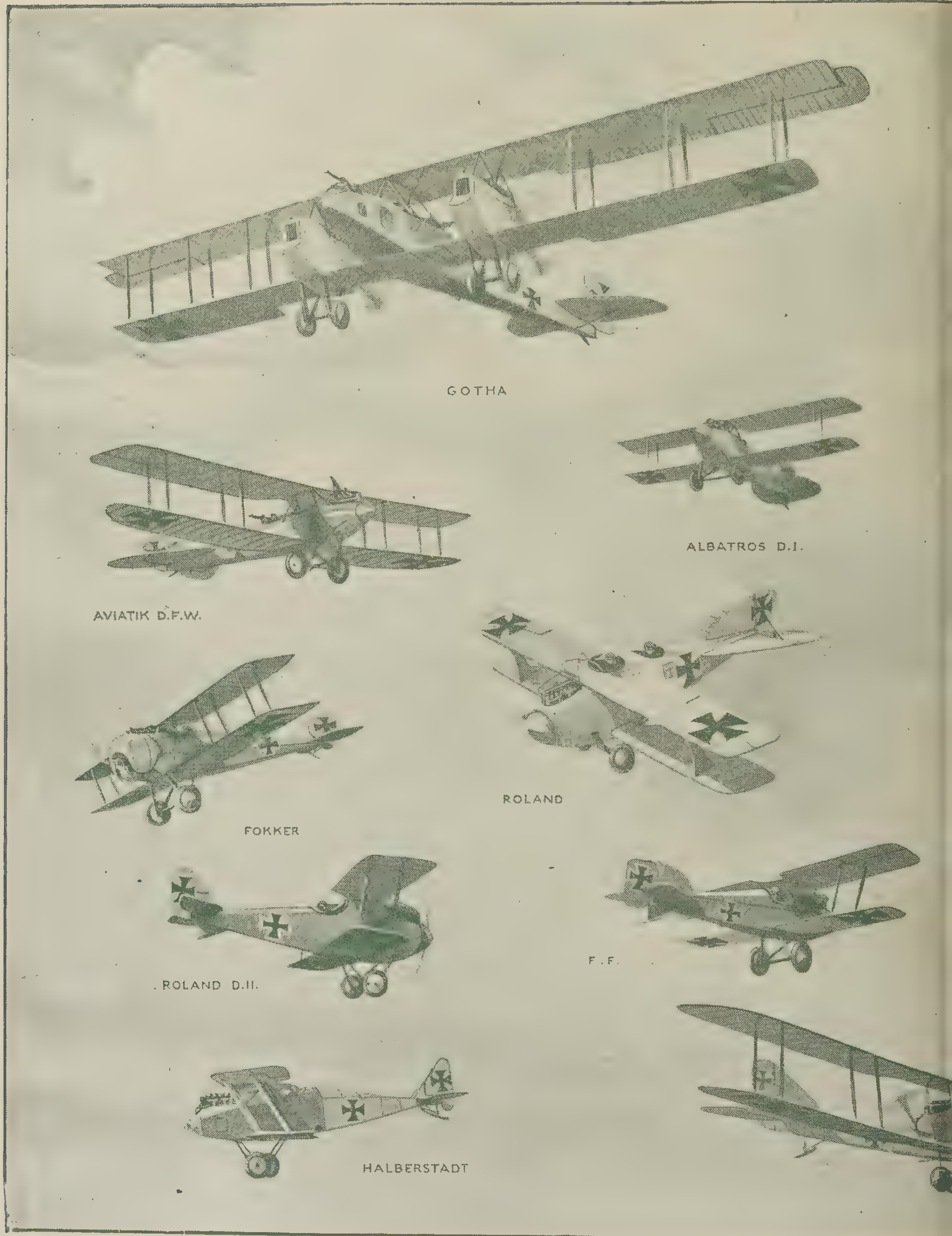




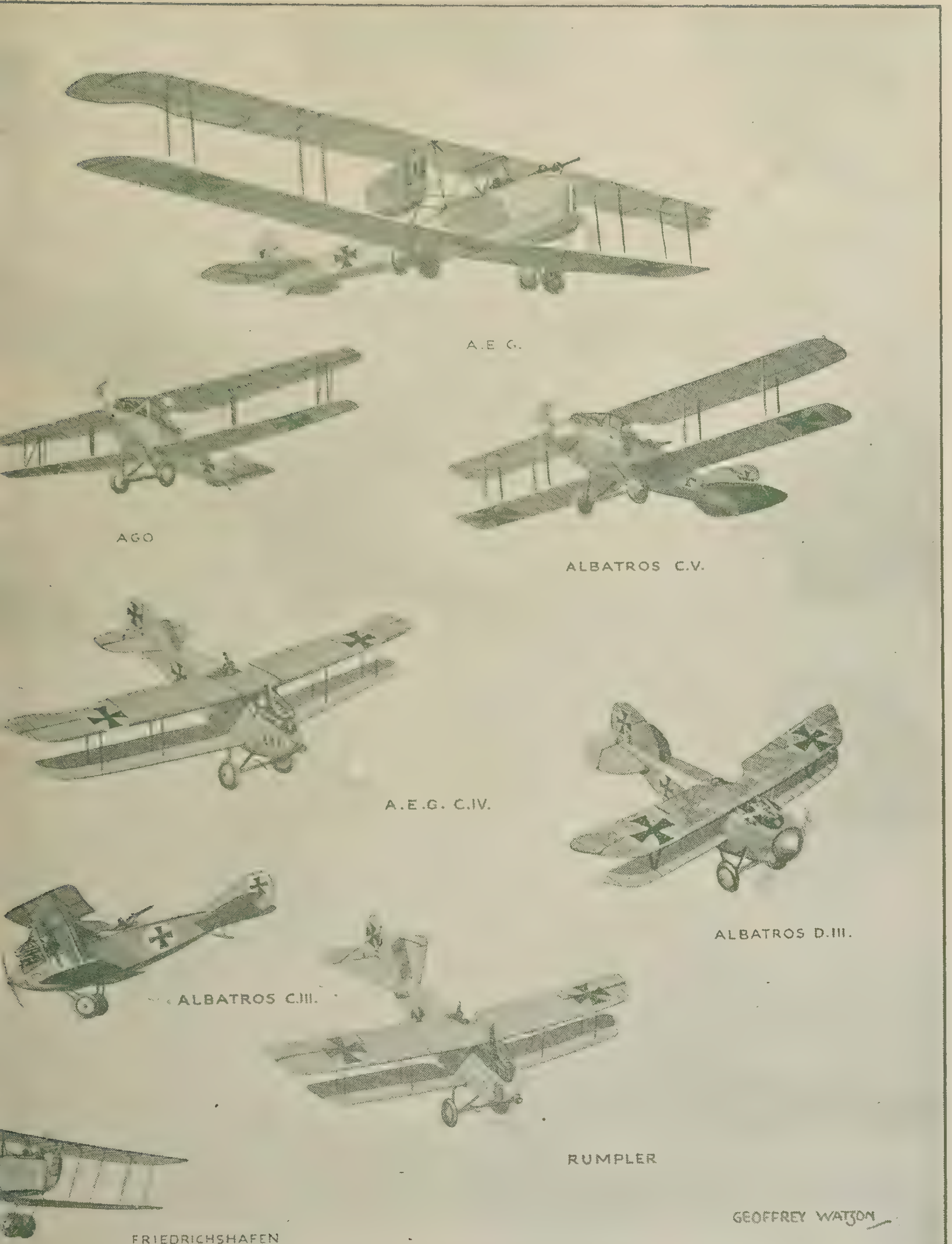
[French Official.

THREE HUGE BOMBING MACHINES: ITALIAN, BRITISH AND FRENCH.

1. Caproni Triplane; 2. Handley Page Bomber; 3. Breguet Bomber (against it is a Nieuport Chaser, which acted as escort). A feature of the Breguet is that every possible part is of metal.



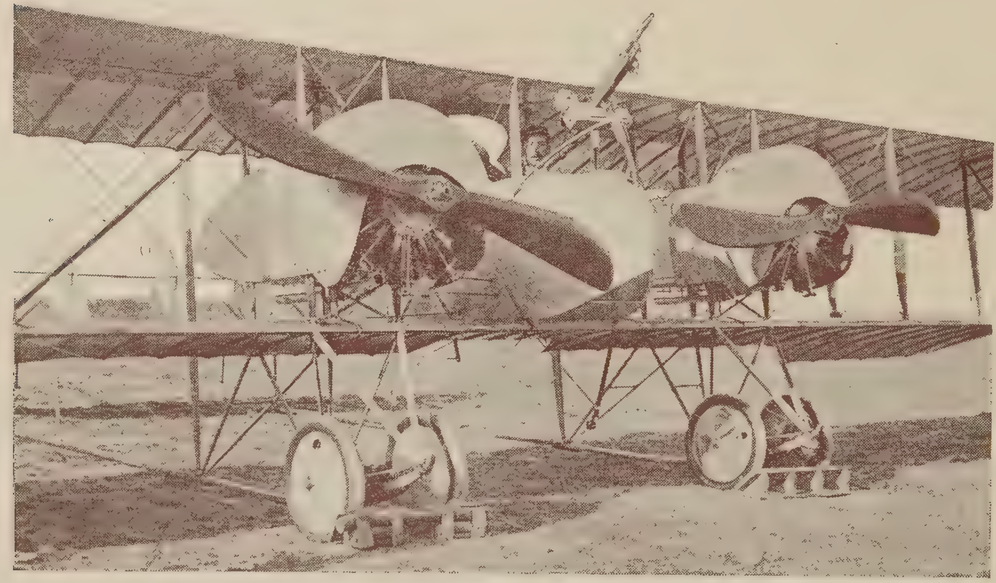
TYPES OF GERMAN AND AUSTRIAN


A.E.G.
AGO
ALBATROS C.V.
A.E.G. C.IV.
ALBATROS D.III.
ALBATROS C.III.
RUMPLER
FRIEDRICHSHAFEN
GEOFFREY WATSON

[From "The Aeroplane."

LANES USED DURING THE WAR.

power. Carrying 21 passengers, a two-engined machine in July, 1916, reached a height of 7,000 feet, and on the 15th November, 1918, a four-engined giant made a flight over London at a height of 6,500 feet with over 40 passengers. In a general way it may be said that the Handley Page ranks as the most powerful type of weight-carrying land machine yet built. A copy of it was the German Gotha, which, from specimens that were brought down by the Allies, seems to have been designed from the Handley Page that unfortunately fell intact into German hands soon after the design was perfected. Such a machine is, of course, of little use for scouting work, or for any task involving swift manœuvring, but for raiding and for long-distance work it proved very well—as the Rhineland towns discovered to their cost—what a big machine is capable of doing.



[*Central News.*

A FRENCH TWIN-MOTOR CAUDRON BIPLANE.

Another huge machine was the Russian Sikorsky biplane, which was planned in 1913 by a young Russian engineer. It carried sixteen passengers, or an equivalent weight, and had a speed of 90 miles an hour, being driven by four 100 h.p. engines, which were controlled from the pilot's cabin. There were two sets of controls, and each engine drove a separate propeller. The Sikorsky, in spite of its size, was comparatively easy to manœuvre in the air.

Yet another of the giants is the Caproni biplane, which during

[*F. N. Birkett.*

A DE HAVILLAND.

Types of this machine are known by a sequence of numbers, 4, 5, and so on. The American Government used large numbers of "No. 4," and the daylight bombing of German towns was mainly done by D.H. 10's. The altitude record of 30,500 feet was made by a British pilot on a D.H. 9, fitted with a 450 h.p. Napier engine.

the War accomplished some fine flights, including one from Turin to London (656½ miles), in 7 hours 22 minutes.

Unless a machine is a monoplane, or has twin propellers, it is almost impossible to distinguish between the various types while they are in flight. It is easy enough, of course, to recognize the single planes by sight, and the existence of the twin propellers by hearing —a machine with twin propellers makes varying notes, instead of

[*E. N. A.*

A GERMAN GOTHA.

This type of machine, which was largely used for raids on England, was remarkable for the closed-in carriage and was to a large extent a copy of the British Handley Page.

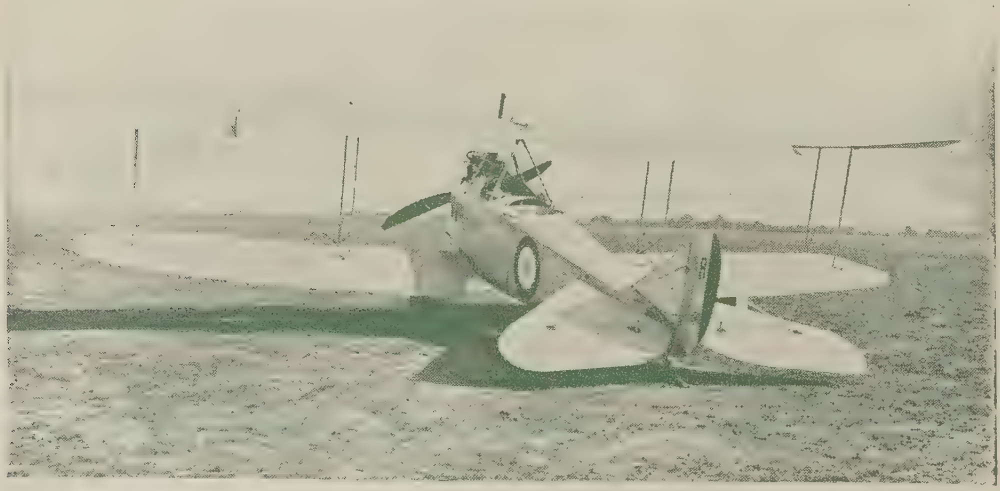
[French Official.

A LARGE MORANE BIPLANE.

[E. N. A.

THE RUSSIAN SIKORSKY BIPLANE.

This huge machine, built before the War, carried sixteen passengers and was driven by four 100 h.p. engines. It flew over St. Petersburg for 1½ hours.



[French Official.

A FRENCH "RUMPLER."

[*F. N. Birkett.*

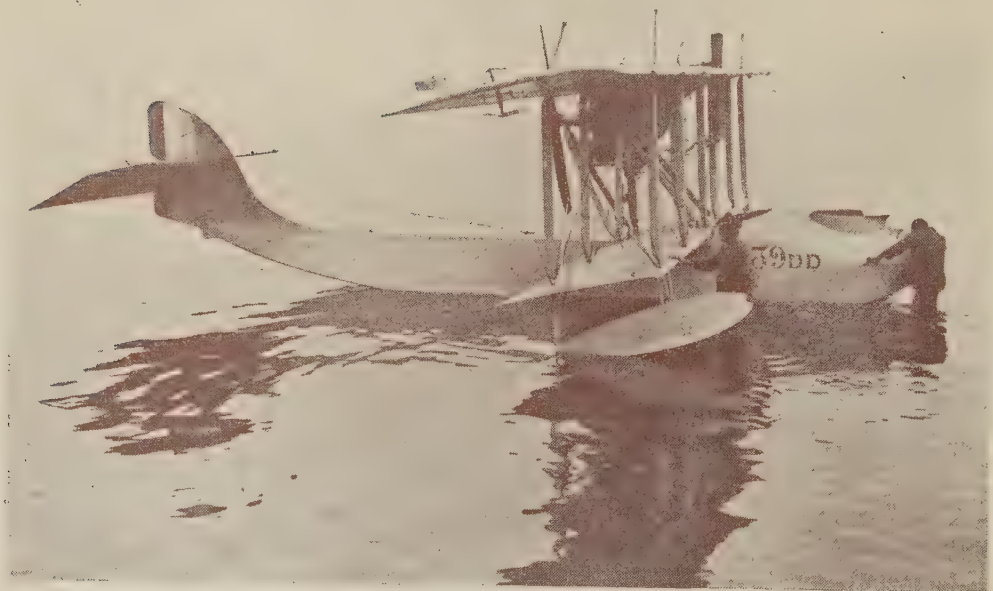
[*Farringdon Photo Co.*

THE GRAHAME WHITE "AERO-BUS."

In pre-War days this machine used to make frequent exhibition flights at Hendon with as many as eight passengers. The usual charge for a trip was two guineas per head.

the steady buzz that comes from a single propeller. The construction of the under-carriage, with its little boats, marks the seaplane out from the land machine, and here again recognition is easy. But the biplane, whether scout or fighter, is much the same in appearance; the "pusher" type can be recognized by its skeleton body. The "tractor" type, in which the propeller is in front of the body, is covered with fabric or metal from head to tail, but this is impossible with the "pusher" type, since there must be a break in the body to make room for the propeller, so that from the back of the planes to the tail there is a skeleton arrangement of girders instead of the more common boat-shaped construction of the "tractor." Strictly speaking, as the majority of modern machines are "tractors," it is not accurate to speak of "propellers," and the Aeronautical Society prefers the use of the term "air-screws."

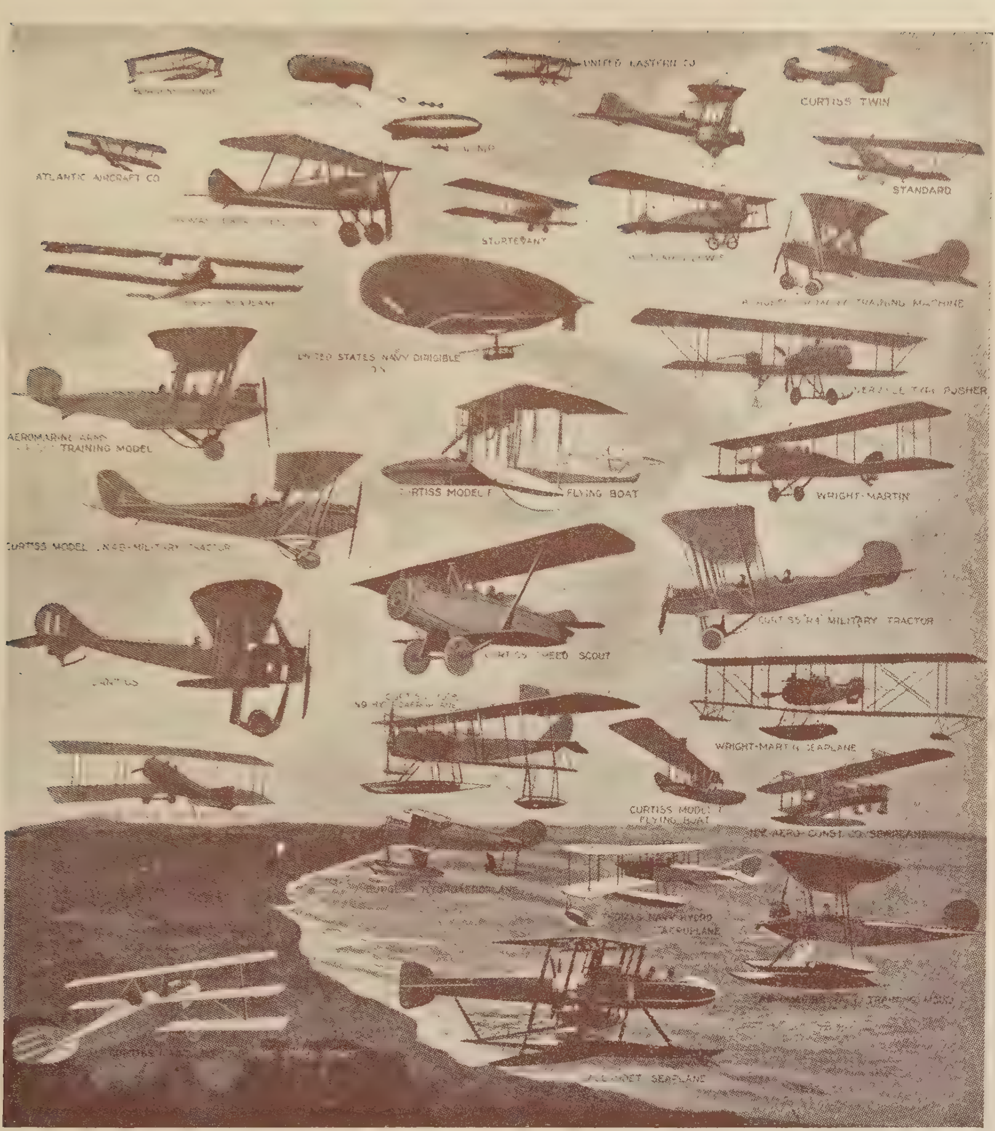
E. CHARLES VIVIAN.



[French Official.

BIRD OR FISH?

Overhauling a French seaplane prior to a flight.


UNITED EASTERN CO
CURTISS TWIN
ATLANTIC AIRCRAFT CO
STANDARD
STURTEVANT
UNITED STATES NAVY DIRIGIBLE
VERVILLE TYPE PUSHER
AEROMARINE ARMY TRAINING MODEL
CURTISS MODEL F FLYING BOAT
WRIGHT-MARTIN
CURTISS MODEL JN4B MILITARY TRACTOR
CURTISS SPEED SCOUT
CURTISS "R4" MILITARY TRACTOR
WRIGHT-MARTIN SEAPLANE
CURTISS MODEL F FLYING BOAT
N.Y. AERO CONST. CO. SEAPLANE
THOMAS NAVY HYDRO AEROPLANE
GALLAUDET SEAPLANE

[Reproduced, by permission, from "The Scientific American."

TYPES OF AMERICAN AIRCRAFT.

Top Row (left to right).—Burgess-Dunne—Goodyear Kite Balloon—United Eastern Co.—Curtiss Twin.

Second Row.—Blimp—L. W. F.—Standard.

Third Row.—Atlantic Aircraft Co.—Thomas-Morse Speed Scout—Sturtevant—Witteman Lewis—Burgess Primary Training Machine.

Fourth Row.—Benoist Seaplane—United States Navy Dirigible D.N.1—Verville Type Pusher.

Fifth Row.—Aeromarine Army Training Model—Curtiss Model F Flying Boat—Wright-Martin.

Sixth Row.—Curtiss Model JN 48 Military Tractor.

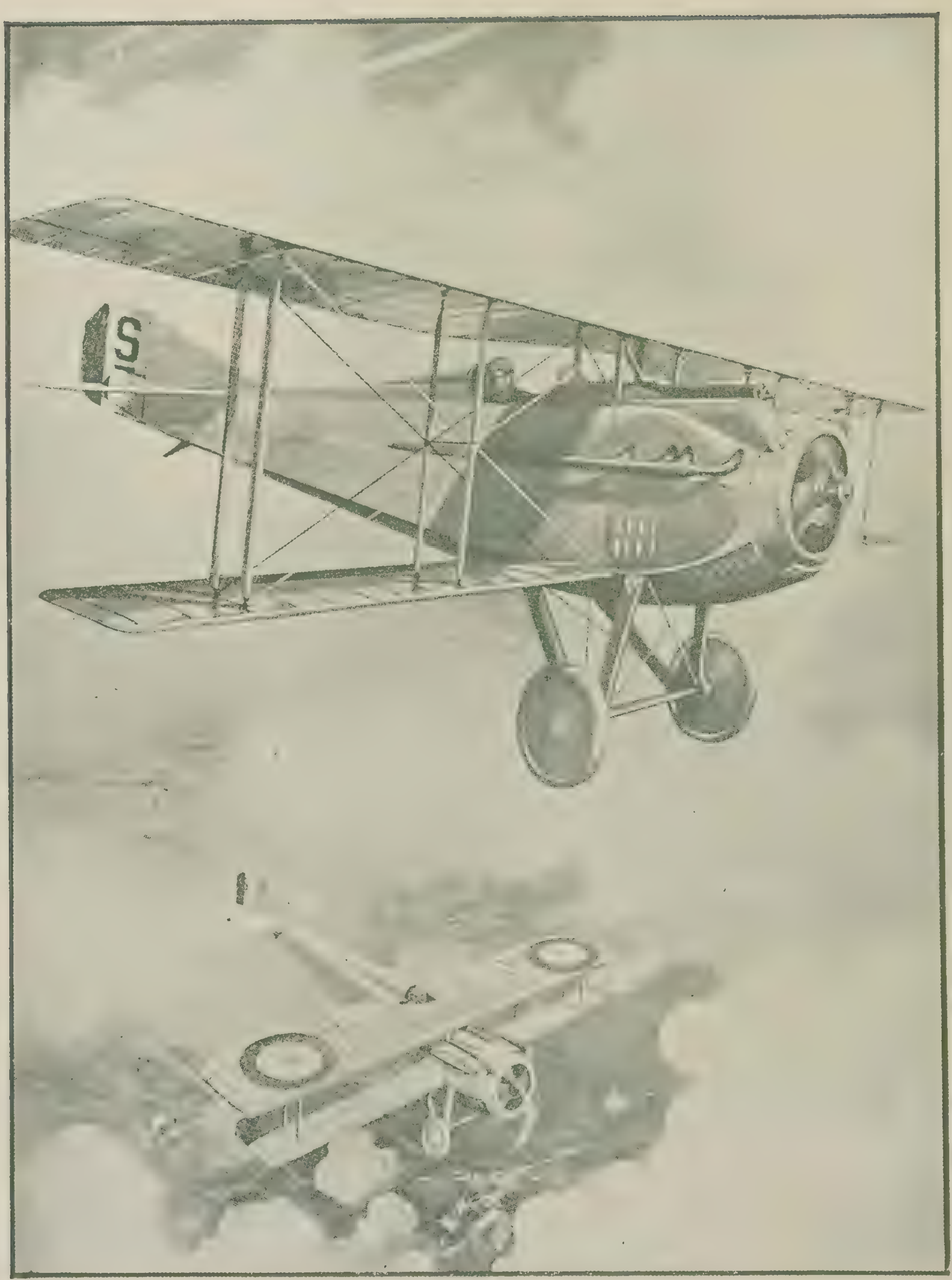
Seventh Row.—Lanzius—Curtiss Speed Scout—Curtiss "R4" Military Tractor.

Eighth Row.—Curtiss Model N9 Hydro-aeroplane—Wright-Martin Seaplane.

Ninth Row.—Empire State Aircraft Corp.—Curtiss Model F Flying Boat—N.Y. Aero Const. Co. Seaplane.

Tenth Row.—Burgess Hydro-aeroplane—Thomas Navy Hydro-aeroplane.—Aero-marine Navy Training Model.

Eleventh Row.—Curtiss Model Triplane Speed Scout.—Gallaudet Seaplane.



A FAMOUS FRENCH FIGHTER : THE S.P.A.D. SINGLE-SEATER BIPLANE.

This machine, capable of 132 miles an hour, was used by Captain Guynemer and other famous French pilots. It was copied by the enemy in their "Albatros," nicknamed the "German Spad."

[*French Official.*

A ZEPPELIN DOWN IN FRANCE.

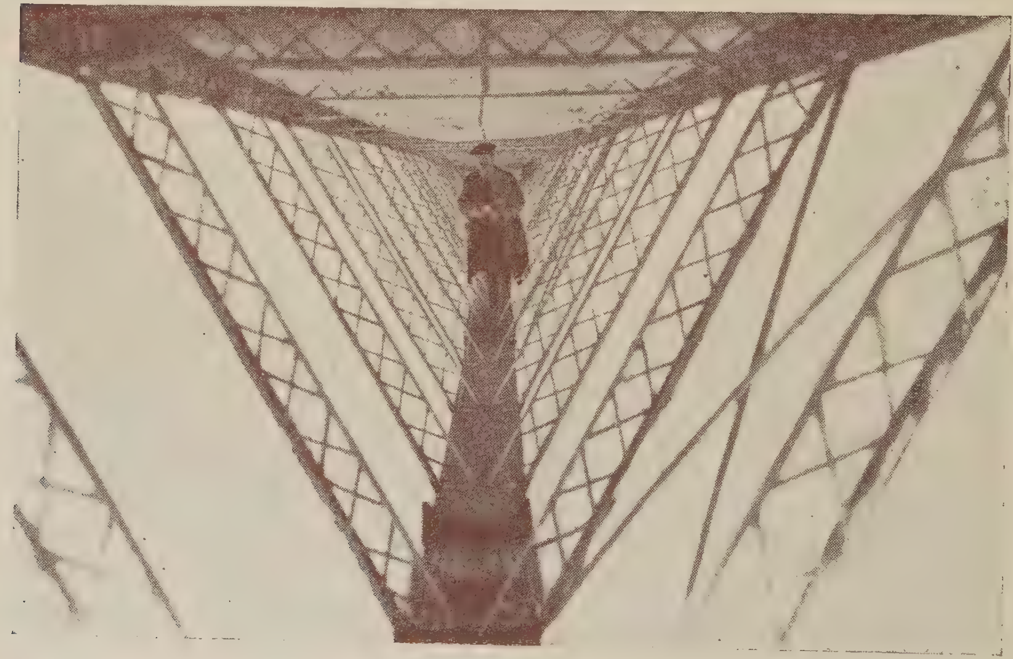
Airships and their Use in Warfare

IT became a popular fallacy in the earlier period of the War to describe all airships as "Zeppelins," partly perhaps because large numbers of people had never seen an airship, while nearly everyone had looked at photographs of the "Zeppelins" which were brought down.

There are three types of airships: rigid, semi-rigid, and non-rigid. Count Zeppelin placed his faith in the rigid type, and in many ways he proved to be right. But because a German was successful on certain lines with one type is no reason for mankind generally to call all airships "Zeppelins." Great Britain, France, Italy, and the United States have all built airships more or less successfully.

By the rigid type is meant that there is a frame-work of light metal, such as aluminium, over which is stretched an outer covering of light weather-proof material, the whole containing small balloons or balloonettes, which hold the hydrogen necessary to give buoyancy. The vessel from nose to tail may be 600 feet long or more, with a diameter of from 90 to 100 feet. If you consider that 600 feet is nearly one-eighth of an English mile, and that an airship of this length, standing on end, would be nearly twice as high as the cross of St. Paul's Cathedral, you will get some idea of the enormous dimensions of these unwieldy monsters.

Suspended beneath the forward end is a gondola in which the commander has his place, and from which he navigates and generally controls the movements of the vessel. Besides the commander, a crew of over a dozen men is necessary for steering, bomb-dropping, and telegraphing. The propellers are worked from gondolas placed aft, and within these are powerful machines, which by means of the propellers drive the ship forward up to about 60 or 70 miles per hour. To proceed from the forward gondola to the after ones it is necessary for a man to ascend into the envelope of the airship and walk along a narrow gang-plank, known as "the cat walk," only 4½ inches in width, supported on slender aluminium girders. This requires steady nerve, especially when the airship is bucketting about in a heavy wind, and the only support the man has, to enable him to keep his balance and to prevent him from falling through the thin outer envelope, is a slender wire jackstay.



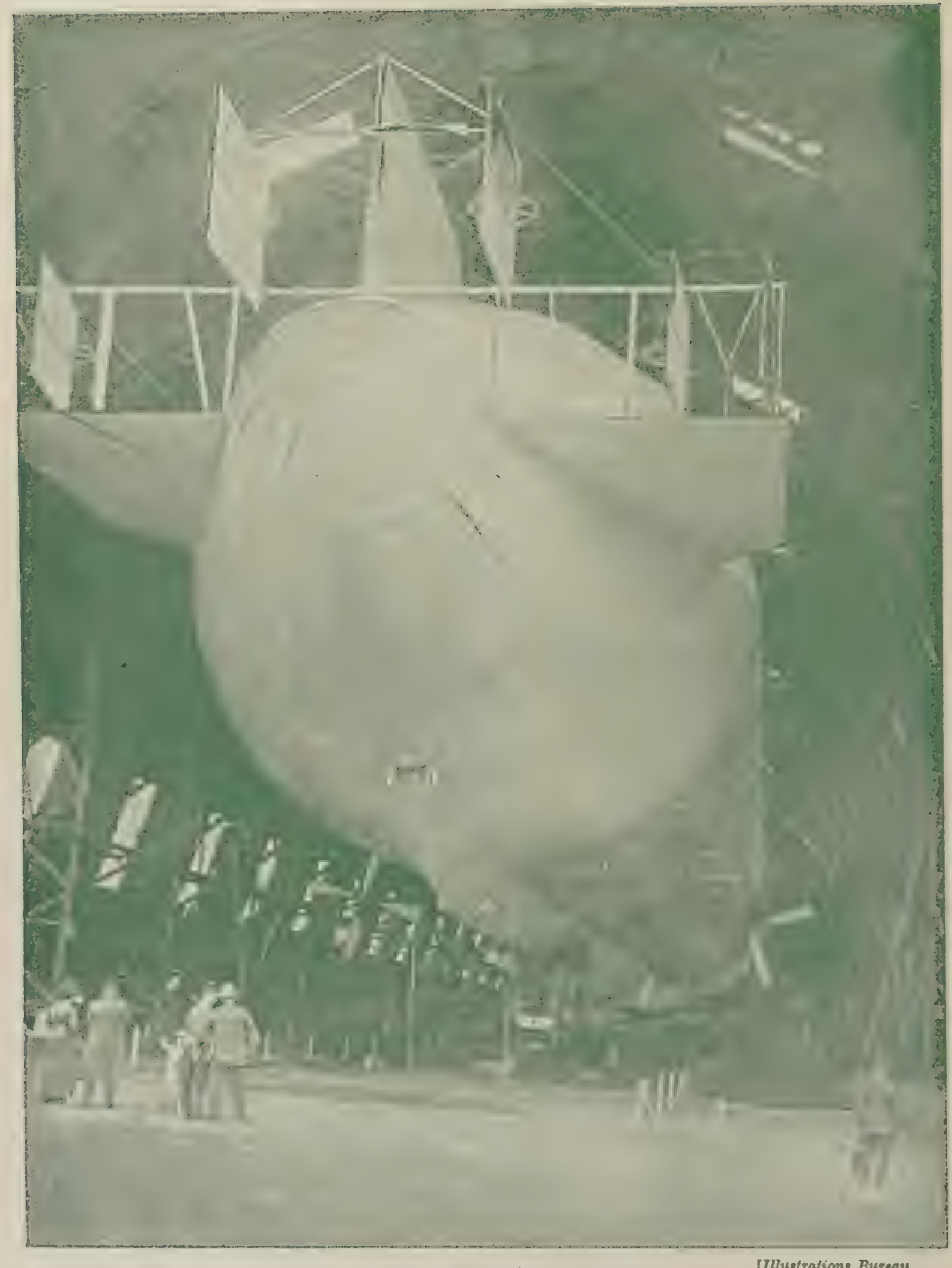
[Illustrations Bureau.

THE "CAT WALK" OF A ZEPPELIN.

By means of this narrow gangway it is possible to pass from end to end (*see also* p. 110).

A ZEPPELIN AT SEA. [E. N. A.

Besides these slender fore and aft communications inside the airship, there is a vertical ladder, which leads through a sort of tube on to the roof, on which is often placed a gun for repelling aeroplane attacks, the platform being protected by a slender wire enclosure. The airship also has a wireless room, and compartments containing water for ballast, bombs, ammunition, etc.



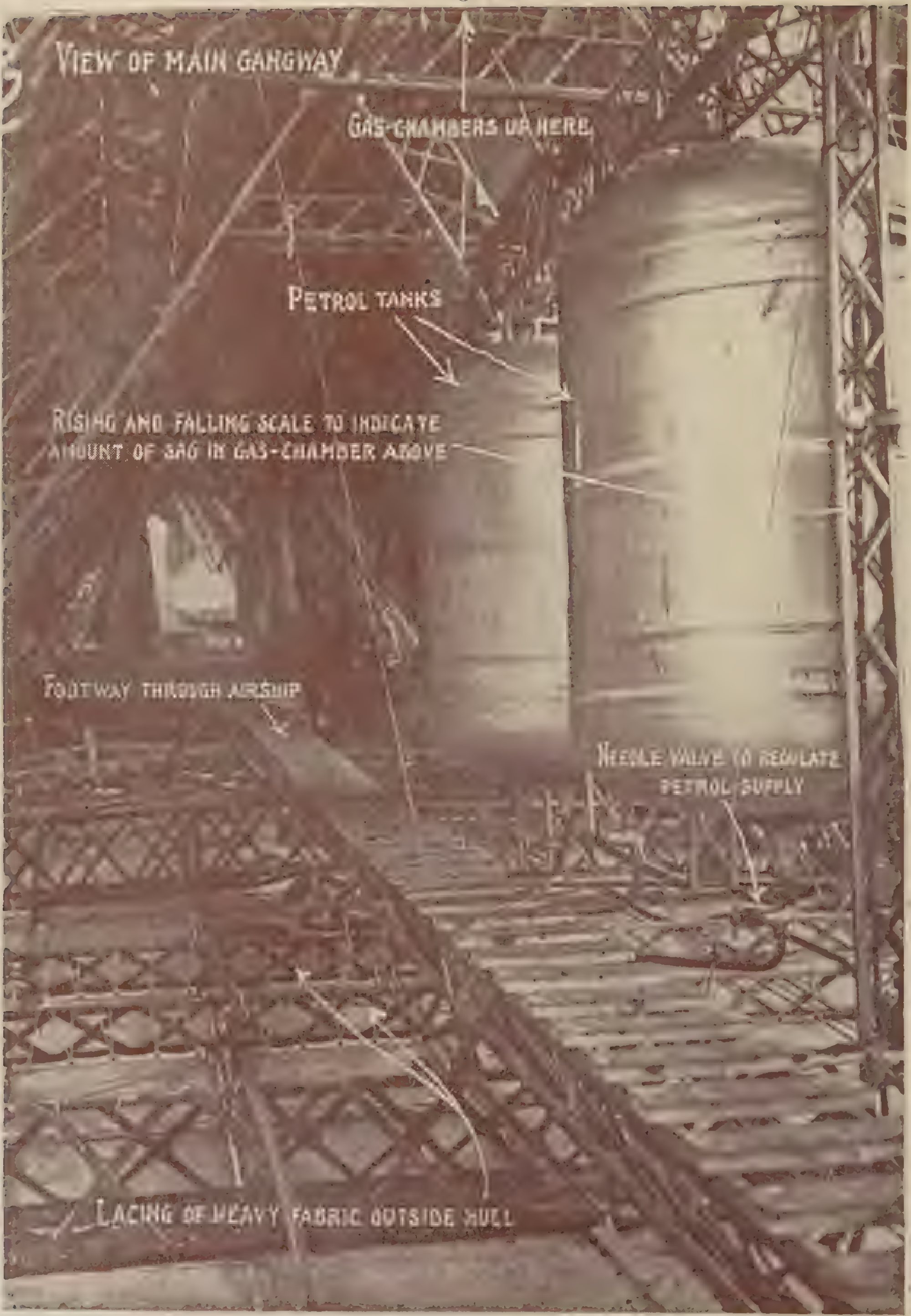
[Illustrations Bureau.

A ZEPPELIN "AT HOME."

[E. N. A.

THE RAIDERS.

A German picture showing Zeppelins on the way to England. Note the gun platform on the rear vessel.


VIEW OF MAIN GANGWAY
GAS-CHAMBERS UP HERE
PETROL TANKS
RISING AND FALLING SCALE TO INDICATE AMOUNT OF SAG IN GAS-CHAMBER ABOVE
FOOTWAY THROUGH AIRSHIP
NEEDLE VALVE TO REGULATE PETROL SUPPLY
LACING OF HEAVY FABRIC OUTSIDE HULL

[Topical

INSIDE A ZEPPELIN.

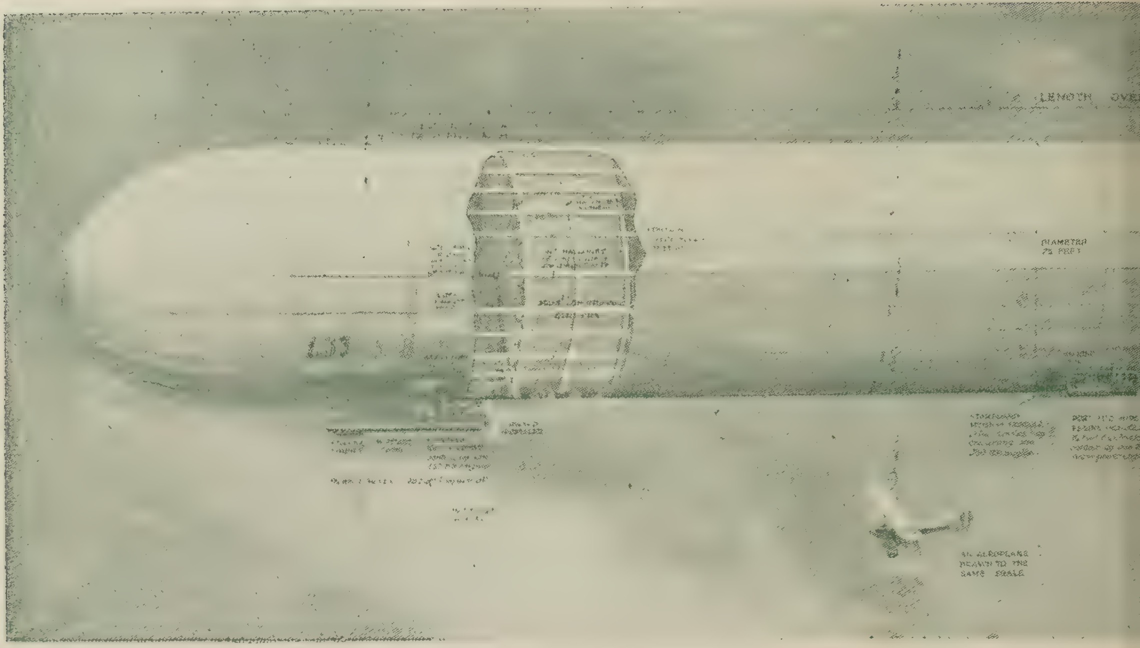
This photograph of a Zeppelin which was brought down in France shows the "cat walk," or gangway, through the airship, and the enormous twin petrol tanks.

In summer weather a trip in an airship may be a pleasant experience, if one forgets the manifold dangers to which it is liable even in peace-time. In early days, time after time, an airship would leave its large shed and sail away in ideal weather, only to be wrecked on its return, either through the force of a sudden gale, or through crashing into a forest owing to loss of lifting power. Some have fallen into the sea, with the loss of a large part of the crew.

[*Sport and General.*

A ZEPPELIN BROUGHT DOWN NEAR LONDON.

In warfare, it was soon proved that the Zeppelin is a very vulnerable ship indeed. It can beat an aeroplane by its great speed in rising to a high altitude, and its actual speed through the air, though considerably less than that of the aeroplane, is greater than that of the fastest express; but once the aeroplane has got above, then despite the gun mounted on top, the Zeppelin has generally fallen a victim to the smaller craft, its very bulk making easier its destruction.



ONE OF THE LATER ZEPPELINS, WITH

Even now, comparatively few people realize the large size of these monsters. This one is 680 feet in length (St. Paul's
per hour, but much depends on the wind.
In the drawing a portion of the outer fabric has been removed, to show the interior construction, with one of the bal-
and the forward and two midship gondolas one each ; making a total of 1,500 horse-power. In some Zeppelins

The airship has never proved a very successful means of attack in day-time, because if it flies low enough to bomb particular objects with accuracy it becomes an easy target for anti-aircraft guns. If it goes high it cannot hope to hit anything in particular, and moreover is soon chased and engaged by aeroplanes. Consequently Zeppelin raids were generally made by night. But if the night was clear the Zepp was soon picked up by the searchlights, guns opened fire and hostile aeroplanes went up to attack, with the result that the Zepp's fast journey was generally a rapid one to earth, in a sheet of flame.

If an airship flying at night is so high that she cannot see the earth, and if, as may happen, the clouds are so thick that she cannot see the stars, navigation is more than difficult. For instance, she may think the wind is blowing hard from the west, and she may be steering east. If the wind in the higher regions remains in the west, then the airship is all right ; but should the upper wind change gradually to north, the airship has no means of knowing that this has happened (at least she cannot tell accurately), and she may continue to steer east by compass, though her actual course is south-east. If

[Drawn by G. H. Davis and reproduced by permission from "The Sphere."

N AEROPLANE DRAWN TO THE SAME SCALE.
Cathedral is 515 feet in length, including the portico). The diameter is 75 feet. The normal speed is from 55 to 60 miles
loonettes which contain the gas (there are nineteen in all). The after engine gondola contains three 250 horse-power engines
guns were mounted on the top and at the stern.

the airship could see the land below, or the stars above, she would soon find out the leeway she was making; but since she can see neither, she goes on in a blind sort of way and often lands in an enemy country instead of her own. The only chance to overcome this difficulty is either to come down nearer the earth and risk being destroyed by the anti-aircraft guns, or to rise higher. On occasion Zepps have actually gone as high as 23,000 feet; that is, higher than Aconcagua, the highest mountain in the Andes, or more than half as high again as Mont Blanc.

Just think of being up at that height with only the thin protection of the gondola or the flimsy envelope to keep out the cold of a winter night! No wonder that in one recorded case the water ballast froze, the petrol very nearly did the same, and when the Zeppelin descended in the South of France, some fourteen hours later, the top of the gas-bag was covered with frozen snow. The crews of Zeppelins may have been dastardly fighters, if "fighting" their work could be called, but no one can deny that they had pluck and endurance.

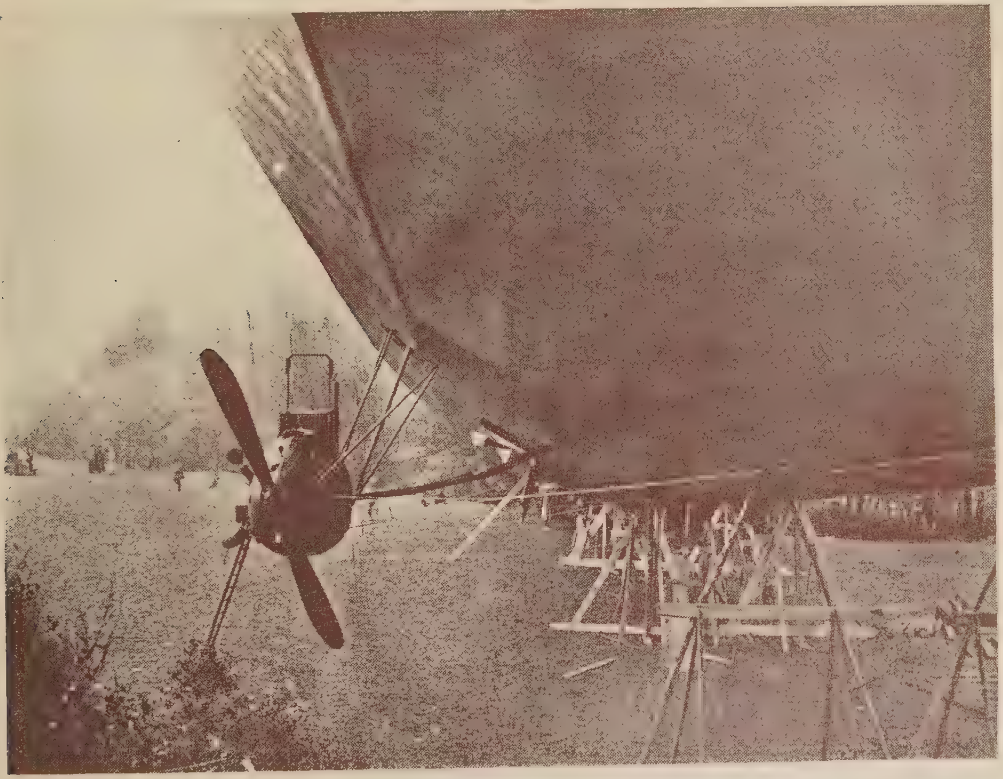
Airships used for the more legitimate purposes of warfare have

[E. N. A.

A ZEPPELIN WRECKED ON THE NORWEGIAN COAST.

on occasion proved of great value. If a fleet employs airships for aerial scouting they can go 20 to 30 miles ahead, rise to 15,000 or even 20,000 feet, and from that height get an extensive all-round view that would otherwise be impossible. Should they sight the opposing fleet, not only can they inform their own Admiral as to the enemy's numbers, but they can give the disposition, the course the enemy is steering, and the approximate speed. Consequently an Admiral who possesses efficient airships, and is allowed by the weather conditions to use them, has an enormous advantage over an opponent who possesses less efficient aerial scouts. He has the power to decline battle and to retire in ample time, or he can call up reinforcements should he possess and need them; alter the disposition of his fleet; in fact, carry out any manœuvre to his own advantage, out of sight of the enemy and unknown to him. But, and this is an important point, his "eyes" are only of use when the weather allows, and when the enemy does not send forth seaplanes to destroy them. No Admiral can be sure that he will have the weather he wants, and in such a place as the North Sea conditions change so quickly and violently, especially in winter, that a squadron of Zepps going gaily ahead of the German Fleet might easily have become but winged ducks in the space of a few hours. The British Fleet makes considerable use of smaller "gas-bags" as scouts, and it also possesses some most efficient seaplanes, the pilots of which care not a straw for weather, and on many occasion were able to give information of the utmost value.

On the whole, Great Britain during the War employed her airships in a more useful manner than did her enemies. They proved especially serviceable in the great hunt for submarines. As you know, the submarine depends for success on being able to hide beneath the sea, and to steal unobserved close to the merchant ship she desires to attack, with just a momentary raising and lowering of the periscope before launching her torpedo. But to do this the submarine cannot go very deep down whilst stalking its prey. Now you all know that if you go fairly high up you can see a long way down into clear water, such as is general well out from land; it is here that our airships came in, because they could "spot" the submarine, which could not see the airship, so that the tables were turned. Given fairly good weather and not too much sea, once an airman had spotted a submarine below the surface it was, humanly speaking, all up, or rather down, with the submarine. A few well-placed specially-designed bombs dropped from



[*French Official.*

A PROPELLER OF ZEPPELIN L149, BROUGHT DOWN IN FRANCE.

[*L. Illustration.*

A FRENCH DIRIGIBLE MANŒUVRING TO APPROACH A SHIP.

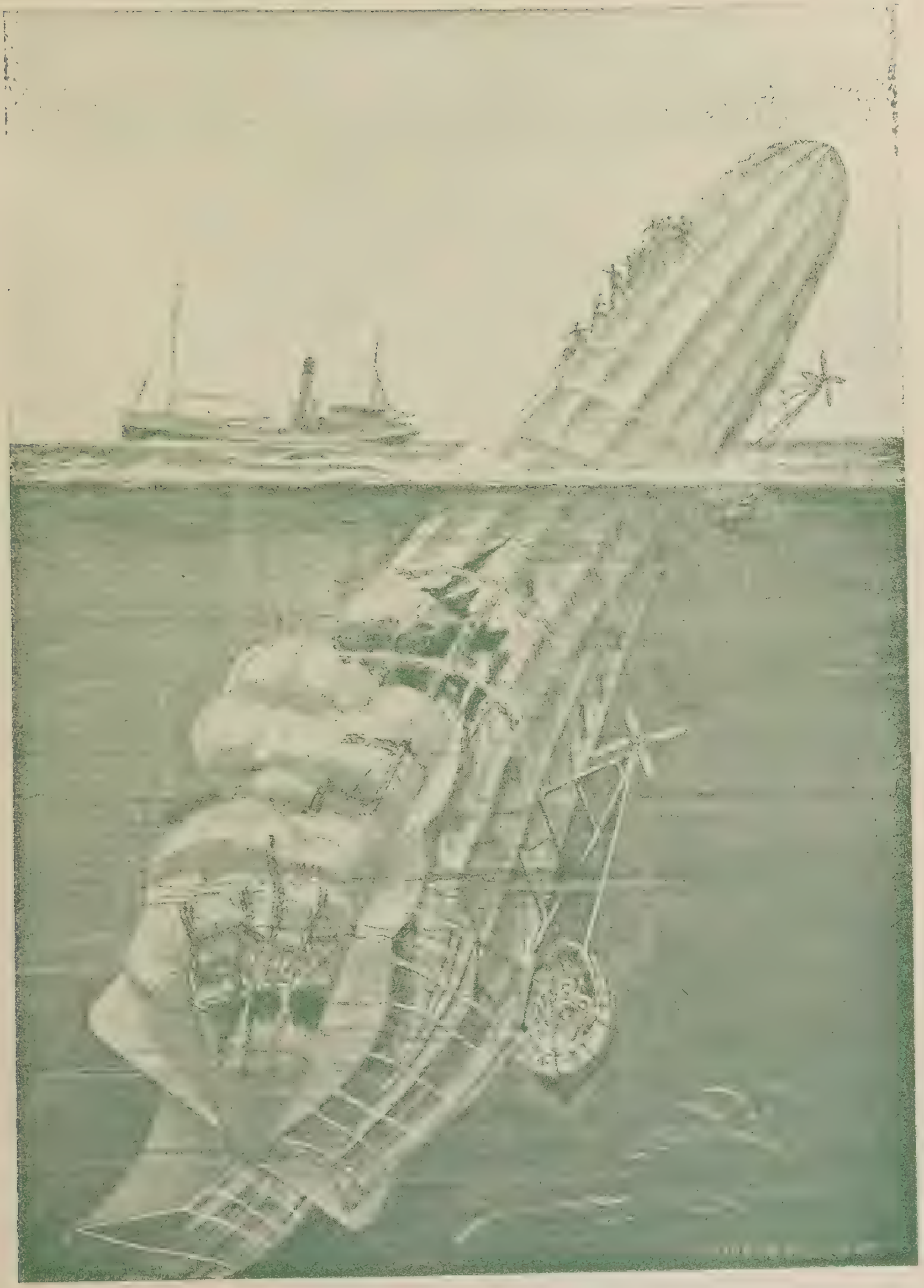
For coast patrol and submarine warfare our Allies have larger airships than the British—"veritable air-cruisers" they have been called. The picture shows the forepart of the navigating car.

the airship and she met the fate she had designed for some innocent merchant ship and her crew.

HENRY HALLING.

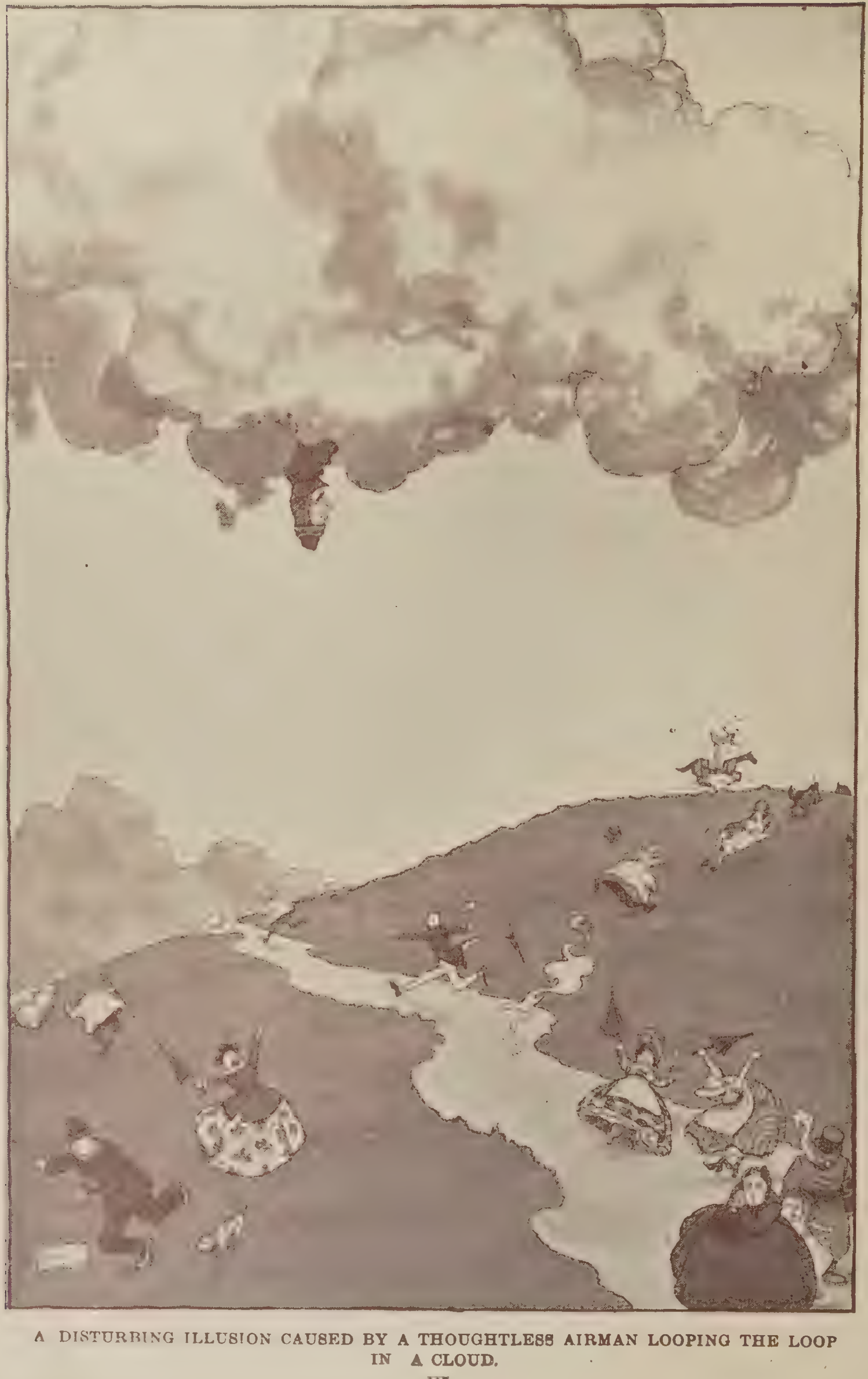
French Official.

FRENCH OFFICERS INSPECTING THE WRECKAGE OF A STRICKEN ZEPPELIN.



A ZEPPELIN SINKING

This shows how the pressure of water burst the gas bags and so completed the destruction of the craft.



A DISTURBING ILLUSION CAUSED BY A THOUGHTLESS AIRMAN LOOPING THE LOOP IN A CLOUD.

"THERE WAS NOT A SOUL IN SIGHT."

His First "Solo"

The Trials of a Cross-Country Flight

THE trouble on emerging from that bothering bank of cloud was to find the railway, for a pilot well "up" has largely to depend on railways, rivers, and the like, for his direction. And, since this was the first time Anderson had been trusted with a "bus" away from the aerodrome, he was desperately anxious to find that railway—far more anxious than he would be later, when more used to flying alone. This, in fact, was his first "cross-country," one of the tests for his "ticket," or pilot's certificate, and he had left the aerodrome with a medley of well-meant hints disturbing his mind.

It occurred to him that the railway might here be in a tunnel, in which case he would not see it from above. No sooner had he thought of this than the railway appeared, trees bordering the line. When he had been at a greater angle the foliage had concealed the metals. Anyhow, there it was; he glanced at his map, and saw that a river should pass under the line if he were anywhere near where he thought he was. But there was no river, and Anderson used strong language with regard to that innocent-looking patch of cloud into which he had slid a minute or so since. On coming out from the cloud the country seemed entirely changed. There was no sign of the aerodrome he had left, nor a sight of any feature he knew.

"And if I sight the sea I shan't know whether it is the Channel or the Atlantic," he told himself.

Then it occurred to him to consult his compass, which told him that, in the bank of cloud from which he had emerged, he had turned without knowing at a sharp angle, and was now proceeding almost directly away from the object of his flight. So he swung the 'bus back to the proper course, and kept an eye on the line which was his guide.

He had the impression, which comes to every beginner, that he had been up for hours; the clock on the instrument board told him that it was not more than fifteen minutes since he had left the aerodrome, but he felt dubious—the clock might have stopped. Beneath him stretched the summer landscape, unfamiliar and endless; he had looked out, when flying with an instructor, during those circular flights at the aerodrome, and now, only ten minutes away, the countryside seemed completely altered.

"Two churches close together and a factory chimney beyond," he told himself. "That's half-way, anyhow." For, in addition to a multitude of directions as to how to make this flight, he had obtained some rule-of-thumb directions from another budding pilot who had already been over the course. Being an average youth, Anderson had little faith in maps. From his point of view, a map was a thing that showed you what the country *ought* to look like, but never did look like, when you were flying. He had not the genius for map-reading that comes with experience; and, apart from that, the flier has to adapt his ideas of the map to what the country looks like from a height, and that takes time.

Having passed over the two churches that stood close together, with the factory chimney on the far side, Anderson felt reasonably satisfied with himself, and confident that the rest of the flight was nothing to bother about. Then there came into the roar of his machine an intermittent ticking sound, varied with sundry pops that were audible above the noise of the mechanism.

"Thunder!" he exclaimed. And then, "Plugs."

"AS THE BULL CHARGED ANDERSON DIVED NEATLY UNDER THE AEROPLANE."

He was right; the trouble was with the plugs. The pops grew in number and intensity till, had a spectator below cared to listen, it would have seemed that Anderson was having some machine-gun practice on his own account. Then, as he peered anxiously over the side of the machine, the inevitable happened; the engine petered out altogether, and he sat in a quiet that was uncanny after the roar of actual flying. In that quiet he realized that he had just about a minute in which to make up his mind where to land, or as to the kind of wreath he would like his relatives to send if he failed to land properly. But he did not bother much about the wreath; finding a landing-place in unfamiliar country was trouble enough.

"A half turn takes me nicely into the wind," he said aloud, and was surprised to hear his own voice. This quiet gliding was weird after the noise of flight.

Ploughed land and meadow lay below; and, gliding serenely down, he chose a meadow ahead and beneath him. His aeroplane was a safe old school "bus" with a rotary engine; it had suffered from time to time with a strained undercarriage, owing to pupils like himself making bad landings. But on this occasion Anderson made a beautiful landing, one that even the most captious of instructors would not have grumbled at. It is true he had a meadow of about fifteen acres in which to descend, and the mown grass made just as good a landing-ground as the aerodrome itself; but let it be said in addition that Anderson landed "up wind," in the most approved manner, and that he flattened out at exactly the right moment, so that the machine ran a little and came to a standstill with hardly a jar.

There was not a soul in sight; so Anderson got out from the seat, disregarding a peaceful-looking cow at the far end of the meadow. He reached up at the front of the machine, putting his hand on the engine to see if it were cool enough for him to investigate the defective plugs, and found it was not. He sucked his burnt fingers wrathfully, and the peaceful-looking cow raised its head and stared. He continued to suck his fingers and the cow went on staring. Finally it moved over slowly to make a closer inspection.

Still disregarding the animal, Anderson got out a spanner, with which he meant to attack the plugs, also a pair of pincers with which to deal with the magneto terminals. The next thing was a sudden snort behind ; turning quickly, he saw that what he had taken for an inoffensive cow was a bull, and not an inoffensive bull either. It was pawing and tearing up the ground, preparatory to waging battle with this intruder on its pasture. Anderson threw his spanner in toward the seat in the "'bus," and as the bull charged dived neatly under the body of the aeroplane, coming up on the other side, facing his opponent.

The bull was badly puzzled. He came up with a jerk within two feet of the body of the aeroplane, not daring to touch that shining surface; he badly wanted to get at Anderson, who disrespectfully put his thumb to his nose and spread out his fingers from the other side of the aeroplane body, remarking cheerfully, "Yah, would you?"

With another series of snorts the bull went round by the propeller end, and Anderson again dived under the aeroplane just in time. In spite of his wrath, the bull was a cunning old brute. He again started to chase by the propeller end of the machine, changed his mind halfway, and returned the way he had come. By that time Anderson had made another hasty plunge under the machine, and was just getting on to his feet as the bull got round to the same side to welcome him. He went back once more feet foremost, the bull's muzzle just touching his head as he dropped.

"Thunder; that was a close shave!" he muttered.

Shouts of advice now came to him from the gate of the meadow, more than a hundred yards away. A little crowd had collected; drawn by the fact of an aeroplane descent in the meadow. While the bull was thinking things out a brilliant idea came to Anderson; he climbed back into his seat and crouched low. The bull circled round the aeroplane, more puzzled than ever, realizing that the enemy was there, but knowing of no means of getting at him. The village policeman began to yell encouragement and advice from the gate.

"I'm a pilot, not an acrobat," Anderson called back. "Come and manage your bull yourself."

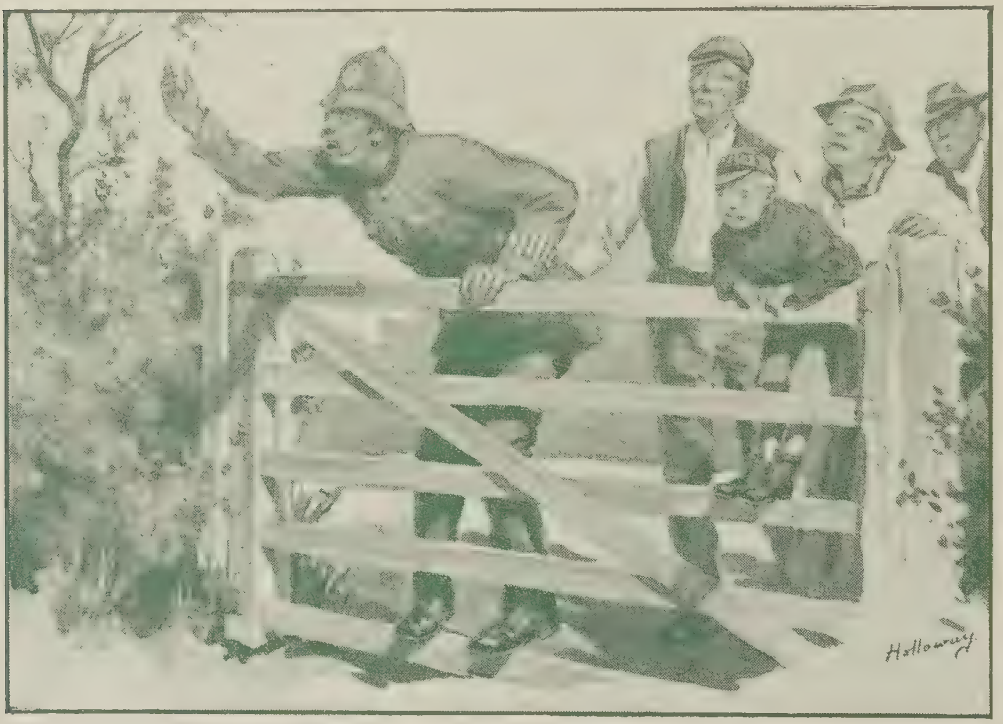
But the bull now strolled off, apparently giving up the game. Anderson got down very quietly, measured with his eye the distance to the gate, and set out. It was the best hundred yards he had ever done, so far as time was concerned, and he fell over that gate and into the road just ten feet ahead of the bull's horns.

"If you will kindly stop here and see that nobody runs away with my aeroplane," he remarked to the policeman, as soon as he had recovered his breath, "I'll go and telephone for some trained bull fighters from the aerodrome."

"Mister," came a voice from the group of spectators, "do I get any compensation for your landing in my medder ?"

"I've had all that out with the bull," Anderson replied gravely. "I want compensation from you for damaged nerves and loss of dignity, so probably the two accounts will square each other."

The policeman expressed himself as quite willing to lean on the gate while Anderson telephoned, and gave directions as to the whereabouts of the post-office, which, fortunately, had a telephone installed. Anderson set out, and, after some delay, got through to the aerodrome.



"THE VILLAGE POLICEMAN BEGAN TO YELL ENCOURAGEMENT AND ADVICE FROM THE GATE."

Having given particulars of the whereabouts of the machine, he continued: "I think it's plugs—a defective overhaul before I started—Yes, the machine is quite undamaged, unless the bull has chawed it up since I left it."

"The bull ?" came back over the wire.

"The bull," Anderson repeated. "It's no use your sending the usual lorry to cart the machine back. What is wanted is a machine-gun squad, properly armed, to get near the thing. And there's a farmer chap hungering for compensation."

"What for?" asked the voice at the other end of the wire.

"Frightening his bull," replied Anderson.

Whoever it was at the other end promptly hung up the receiver at that. Anderson had played practical jokes before.

Feeling that he had done his duty, Anderson strolled back to the gate of the meadow and sat down to wait. The group of spectators had by now grown to quite respectable dimensions.

In the meadow the farmer and his friends were engaged in shepherding the bull into an adjoining paddock. When the animal had been safely secured, Anderson strolled back to his plane, accompanied by the policeman and other interested spectators. Thinking it might be worth while to give the engine a trial, he instructed the policeman and another man with regard to swinging the propeller for starting up—he even showed them how easy it was.

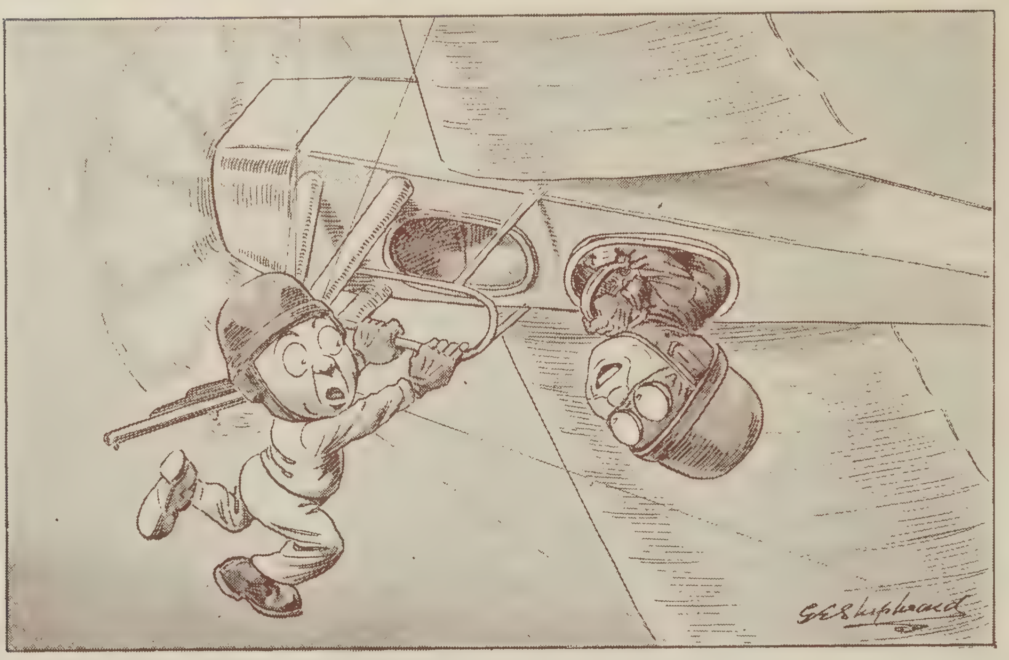
Then, taking his seat, he gave the word, and at the very first attempt the engine roared into life, running perfectly. Anderson opened out, taxied along, and rose clear—they said of him later that he was a born pilot. He swung round into his course, found the railway again, and made for home.

"But what those fellows with the lorry will say when they get there, and find neither the machine nor the bull in the meadow, will be worth hearing," he reflected. "I suppose I shall get another shot at my 'cross-country' to-morrow."

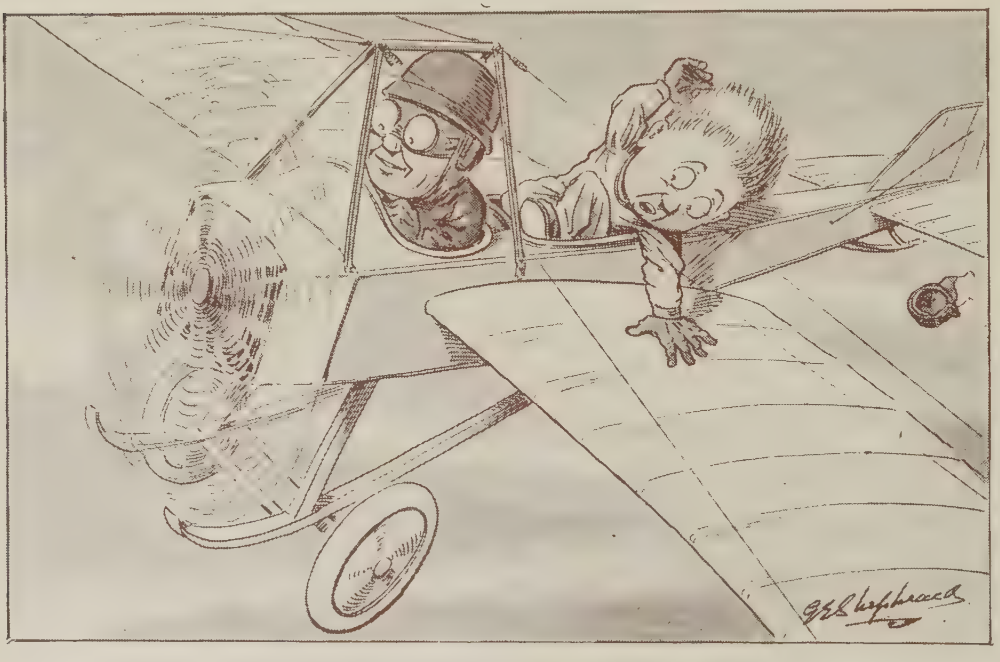
D. S. Mann.

A SLIPWAY FOR LAUNCHING GERMAN SEAPLANES.

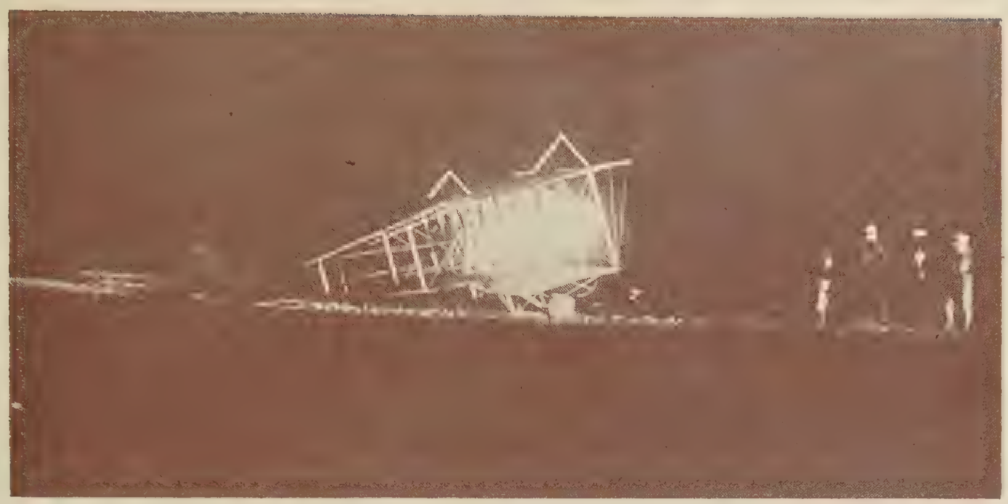
THE TROUBLES OF AN OBSERVER



"WHY DON'T YOU SAY WHEN YOU'RE GOING TO LOOP THE LOOP?"



"STOP A BIT: I'VE LOST MY CAP!"



[Newspaper Illustrations, Ltd.

A FRENCH AEROPLANE STARTING OFF ON A NIGHT RAID, PHOTOGRAPHED IN THE GLARE OF A SEARCHLIGHT.

Night Flying

A MOONLIGHT night in Wartime finds the airmen of both sides busier than during the day. The air will be alive with raiding or battling aircraft, silhouetted against the sky. The din is terrifying. Searchlights flash hither and thither in long, trailing beams, bitten with specks of bursting shrapnel from anti-aircraft guns in all directions. It seems almost as if the carnage and roar of the earth battle of daylight hours has been transferred to the skies.

Enemy machines come slithering across the lines, sometimes singly, sometimes in great squadrons, dropping their bombs, and making off again with all possible speed. But our own men will not be inactive. Away there in the dim mistiness of five and six miles behind the lines craft come climbing into the sky in well ordered formation; pass overhead (visible and highly audible) and then disappear on the enemy's side. Now and again from behind grey clouds enemy craft will dart out to meet them, but night combats during the War were comparatively rare.

One pilot, outward bound with a cargo of bombs, destined for a distant munition factory, chanced to glimpse below a large German aerodrome. Lined across the ground were a squadron of bombing machines waiting to take the air. Without a thought of the danger he was running, he immediately dived down two thousand feet, and,

ITALIAN AIRMEN BOMBING A

A large parachute, bearing an extremely powerful chemical light, was released to light up the scen

STRIAN NAVAL BASE BY NIGHT.

ny machines took part in the raid and all returned safely, after dropping fourteen tons of high explosives.

amidst a cloud of bursting "Archies," dropped his bombs, one after the other, into their midst.

Other pilots would make a practice of diving unexpectedly to within two or three hundred feet of the earth and attacking enemy transport, and the troops in the trenches. The extent of the danger, naturally could not be ascertained at the time. But, with the first streaks of the dawn, our photographic machines would be hovering over the areas and by noon the plates thus obtained would have been developed and compared with previous negatives of the same positions, a wealth of useful information being thereby obtained. Where formerly stood a great German headquarters the photograph would reveal a smudge of battered masonry. A gun position may well have been literally wiped off the map in a night. And a great cavity in the ground would mark the site of what was a giant ammunition dump.

This nocturnal activity was the more wonderful when one considers that night-flying is the most difficult and dangerous form of aviation. However familiar a pilot may be with the country below him, he will find it totally strange at night. If it be dark, but little of the landscape will be visible, and that only in indistinct smudges and blobs of black. On the other hand, the moon has a queer habit of playing tricks, causing familiar objects to peep out of the grey mist of the surface in the weirdest of shapes. Rivers and roads are barely distinguishable except for the wriggling, winding course of the former. A commonplace farm-house will assume the proportions of a munition factory. Low-lying clouds suddenly blot out the face of the earth, and where the mist comes creeping across the fields it resembles nothing more than a huge lake—woods, fields, trenches, villages, all a strange jumble of silver-grey.

The difficulties of getting off the ground, and of landing on the return can be appreciated only by those who have had experience of the air. Words fail to describe the sensation experienced in leaving the ground and plunging at over sixty miles an hour into the surrounding darkness. Tree tops, house roofs, sheds and hangars whizz past by inches. Nothing can be seen. The never-ending roar of the engine fills one's ears. Should that engine fail, there will be a sudden descent into black oblivion below, with the very fair certainty of a broken neck.

The direction of the wind is often doubtful, yet it is necessary for the pilot to fly directly against the wind both in landing and in

THE DIFFICULTIES OF NIGHT FLYING.

Under certain conditions aviators are obliged to use navigation lights for night-flying. The foremost pilot has also dropped a flare to assist him in landing at his aerodrome getting off from the ground. In daylight this is a simple matter. The trail of smoke from a neighbouring chimney or railway locomotive, the "lean" of a captive balloon, will indicate quite plainly the direction of the wind. But at night all such pointers are shrouded in darkness and the airman can only judge direction by previous observation.

In the early days of the War most night flights were made by the pilots alone, the observer being dispensed with whenever possible, for every ounce of lifting power was necessary for the large cargo of bombs. With the improvement of machines "solo" flights at night became the exception rather than the rule. But the nerve strain for the pilot was but little diminished thereby. The first trip is like an unpleasant nightmare, plunging through a permanently darkened, noisy world, without even the relief of the sound of a human voice or the sight of a human face.

The air is bitterly cold, and despite the warmth of a thickly-lined flying-suit after an hour or so both hands and feet are painfully numbed, though latterly an electrical apparatus has been used by means of which the engine generates a permanent current that passes through clothes and gloves alike, giving them artificial heat.

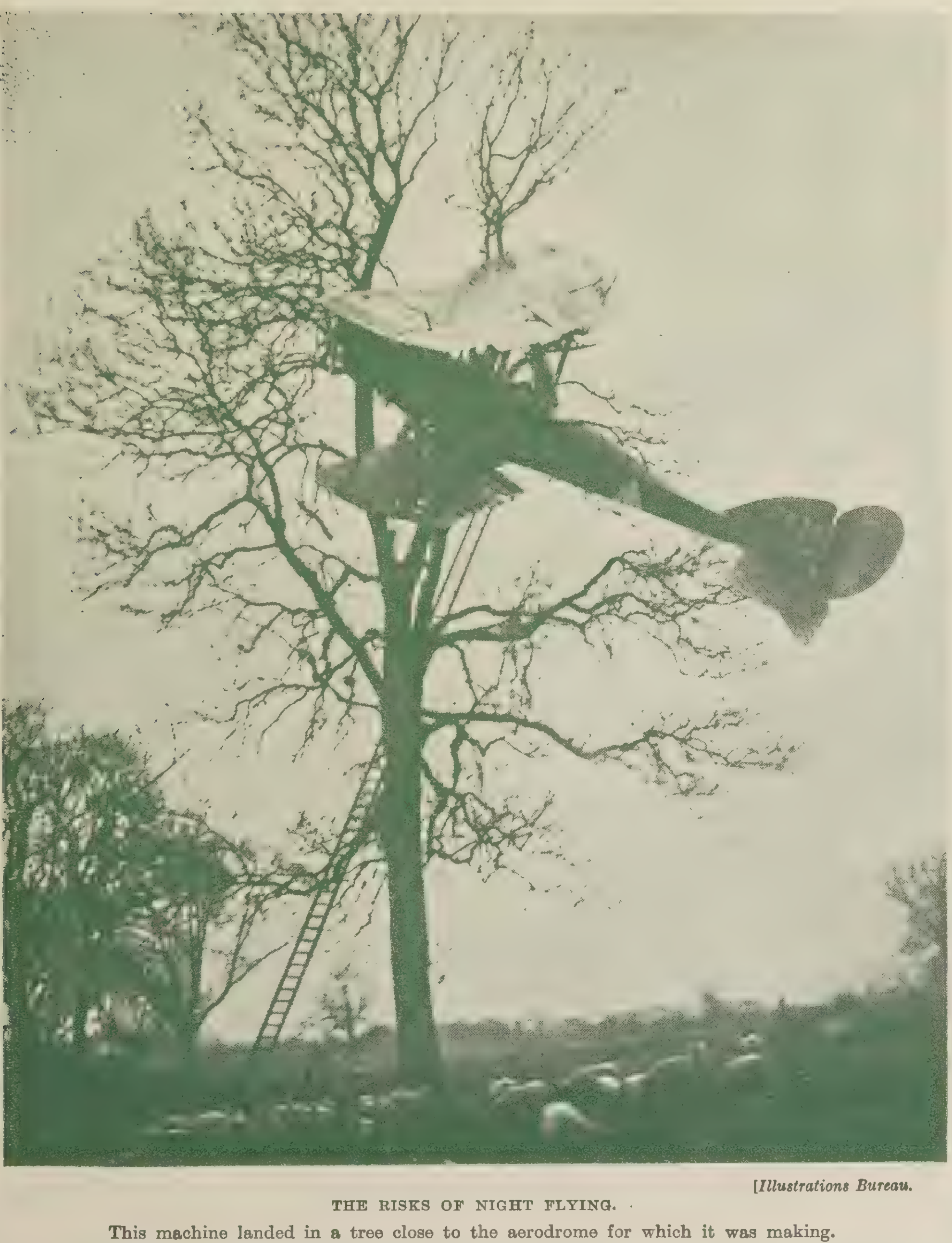
Without all is darkness, but in front of the pilot's seat glows a tiny electric light, which shows him his altimeter, his revometer, his compass, his speedometer, and other instruments.

Having switched on the light, the pilot about to ascend glances at his revometer. Immediately this records the required number of revolutions per minute he waves his arm to the attendant mechanics. The blocks are slipped from beneath the wheels, and away goes the machine across the ground, gathering speed with every yard.

Then troubles begin. On all sides the air is full of "bumps" and "pockets," which have the queerest effect on the machine, causing it to rock in all directions. Below, the roofs of houses and long rows of ugly telegraph wires are in unpleasant proximity, dangers to be avoided before the night hawk can begin his flight.

The start is troublesome enough with a single machine. Imagine the difficulties of an entire squadron leaving the ground one after another, and taking up a pre-arranged formation in the air, a formation they are expected to retain all through the flight.

The queerest and most alarming adventures would often befall a night-raiding squadron. Enemy searchlights would catch machines attempting to slip across at between a hundred and fifty and two



[*Illustrations Bureau.*

THE RISKS OF NIGHT FLYING.

This machine landed in a tree close to the aerodrome for which it was making.

hundred feet, and anti-aircraft guns would blow them to pieces. Engines would fail, and the machines go plunging down into No-Man's Land, from which the pilots often contrived to crawl from cover to cover until they reached the comparative safety of our own trenches.

Into the darkening night once swept a raiding squadron in well-ordered formation, the Captain at their head. Attached to the tail of his machine was a signal bomb. An ammunition dump that was to be bombed lay somewhere ahead.

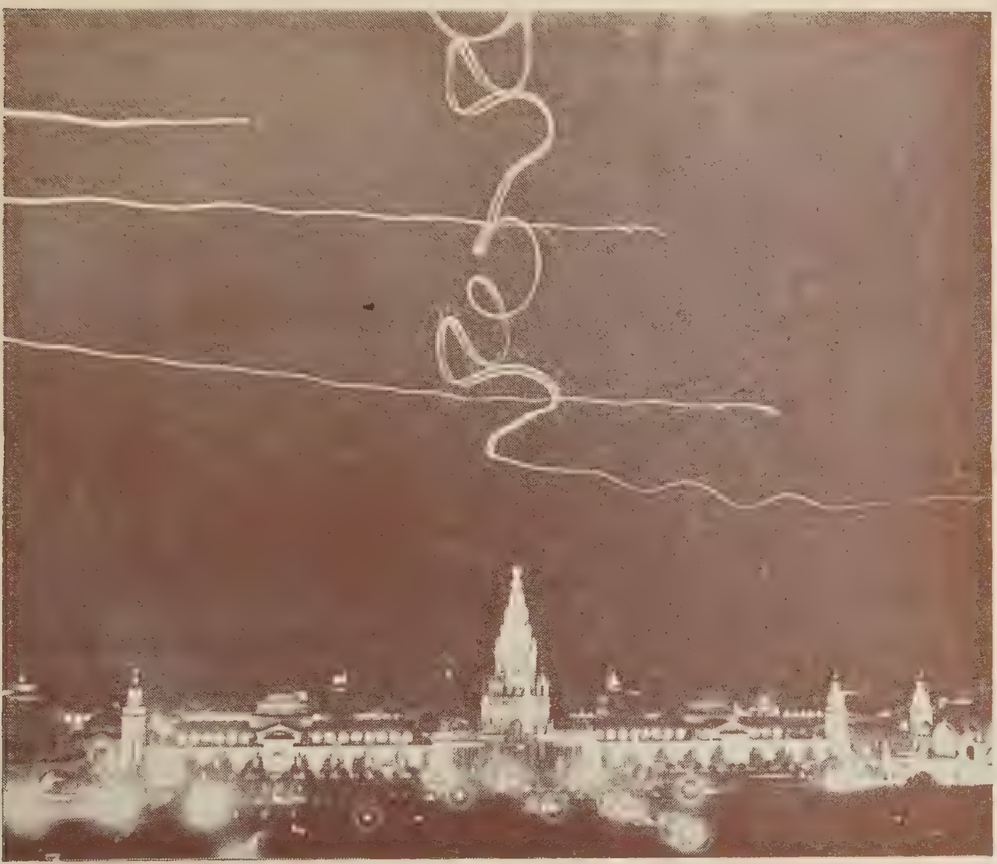
But the Captain's luck was out that evening. Skimming the lines at a bare three hundred feet, a bursting "Archie" caught his machine, and rocketed him to earth. With a heart-breaking bump he hit the earth, nosing head-foremost into a deep shell-hole. By a miracle, he was unhurt, but just as he was congratulating himself on his lucky escape his signalling bomb went off, catching him before he had time to clear the hole. As he scrambled over the top his coat was a mass of flames.

Blindly he forced his way forward, now rolling on the ground in a vain endeavour to quench the flames, now dashing on towards a light he had glimpsed in the distance. Finally, with a gasp of relief, he reached a shell-hole filled with rain water and into this he plunged neck-deep. His cries for help presently attracted the attention of some artillerymen in the neighbourhood and they bore him on a hastily improvised stretcher across three miles of shell-swept area to an advance hospital.

But even without such adventures the experiences of night flying are sufficiently trying. Most arduous of all is the matter of landing the machine.

To enable the airman to see his base from above, a long line of flares is placed round the ground at certain intervals. One of the best of these night-lighting schemes was that sometimes adopted by the Germans. A large white light was placed in the centre of the landing-ground, sunk into a trench, and covered with thick glass to withstand the weight of an aeroplane. At a distance of about 250 feet from this light, and also sunk into the ground, were four red lights corresponding with the cardinal points of the compass. Each of the red lights was connected by subterranean cables to a wind vane mounted on a mast or tower at some convenient point. At night the central light would glow constantly, while the red light in the direction of the wind indicated to the pilot what were the wind conditions on the spot where the landing was to be made. A system of altering the lights was devised, so that an aviator had to understand the code in order to know his whereabouts, and the other side could not use the lights as guides.

Even given a good lighting system such as this it is still a matter of extreme difficulty for an airman to judge his distances in landing. The lights throw eerie shadows across the aerodrome, and height and speed can be easily misjudged, so that landing in the dark demands the most expert airmanship.



[*Record Press.*

A REMARKABLE PHOTOGRAPH SHOWING THE COURSE OF AN ILLUMINATED AEROPLANE FLYING BY NIGHT OVER THE PANAMA PACIFIC INTERNATIONAL EXPOSITION, SAN FRANCISCO.

So much for night flying in the battle area. There remains the important matter of night aerial defence at home.

Three machines, two, or even one might carry out a raid, but to meet that raid effectively required a score or more of defensive craft. The pilots of these had to be ready at a moment's notice to climb to a great altitude and go searching around until they found their enemy.

Imagine the situation. The air is boundless. Width, breadth and height are alike illimitable. In the darkness it was almost impossible to sight the enemy craft, and collision with other craft of one's own side was well within the realms of possibility. In addition, there were all the usual dangers of night flying. For hours on end the airman had to patrol up and down, up and down, in the often vain hope of discovering the raiders.

Driving off Zeppelins was quite a different matter from meeting aeroplanes. Most of us had experience of a "Zeppelin night"; the sudden blaze of searchlights across the face of the blackened sky; the mysterious flashes above and below; the roar of guns, the eerie fascination of the night.

There were signals from the patrolling aeroplanes to the guns, and to the pilots from the aerodromes. Into the far glare of the searchlight crept the long, grey form of the raider. The firing was renewed with a maddened roar, while above and below the big craft fluttered past, like flies, the attacking aeroplanes. Then, as suddenly as the din arose, it died away. The ensuing silence was tense with expectancy, some unknown desire. What had happened?

Suddenly the sky was lit for miles around with a vivid yellow flare. The flame licked along the framework and the gondola of the Zeppelin, and it nosed rapidly to earth, a mass of fire.

The pursuit of these monsters of the night by our gallant airmen makes one of the most glorious chapters in our history, from Robinson, who flew alongside his victim, exposed to machine-gun bullets from the entire armament of the great airship, until he managed to explode a petrol tank, to Cadbury and Pulling, who chased a raiding Zepp far across the North Sea, and after a desperate running fight brought it down in flames.

Of these and similar glorious exploits all that we learnt from the authorities at the time was that, "the raiding aircraft were driven off by gunfire from various defended localities which they attempted to approach," or, "One enemy aeroplane is reported to have been brought down in the Thames estuary, and a second off the coast."

But happily the deeds of the pilots spoke for themselves, and the country realized to the full how much of its security it owed to those daring night hawks.

EDGAR MIDDLETON.

A SEAPLANE BOMBING A SUBMARINE:
A TORPEDO BOAT DESTROYER IS ALSO APPROACHING TO DROP DEPTH CHARGES.

[Canadian War Records.

LIEUT.-COLONEL W. A. BISHOP, V.C., D.S.O., M.C., D.F.C.

This world-renowned Canadian aviator destroyed seventy-three enemy machines during his service on the Western Front.

Brave Deeds of British Airmen

ALTHOUGH new as a field of war, the air speedily became in the recent conflict a realm of heroes. The air affords greater scope than any other theatre of operations for individual achievements. The conditions under which battles on the ground are now fought do not give so many opportunities for soldiers to achieve great feats by the power of their own strong arms as used to be the case when there was more hand-to-hand fighting and a less use of firearms and artillery. But in the air the personal equation remains the chief factor. Combats there are determined by individual skill and valour, and the man is of greater consequence than the machine. And so it comes about that the history of aerial fighting is one long story of heroic deeds that make one's blood thrill with excitement in the reading.

A big volume would be needed to chronicle all the glorious exploits standing to the credit of our flying men during the long years of War.

Pilot and observer climb into their 'bus, and climb skyward at, it may be, seventy-five or over a hundred miles per hour. Presently out of the clouds comes an enemy plane. Like hawks at variance the two dart for one another. With a vicious whirr of hard-driven engines they wheel, dive and climb, each trying to get a position from which he can strike his opponent to earth. Nothing is more fascinating to watch than one of these duels in mid-air; no form of fighting holds such thrills for those engaged in it. Over and around they go, firing their guns, and sometimes looping the loop and performing other acrobatic feats to secure the advantage of height, until finally one is stricken down.

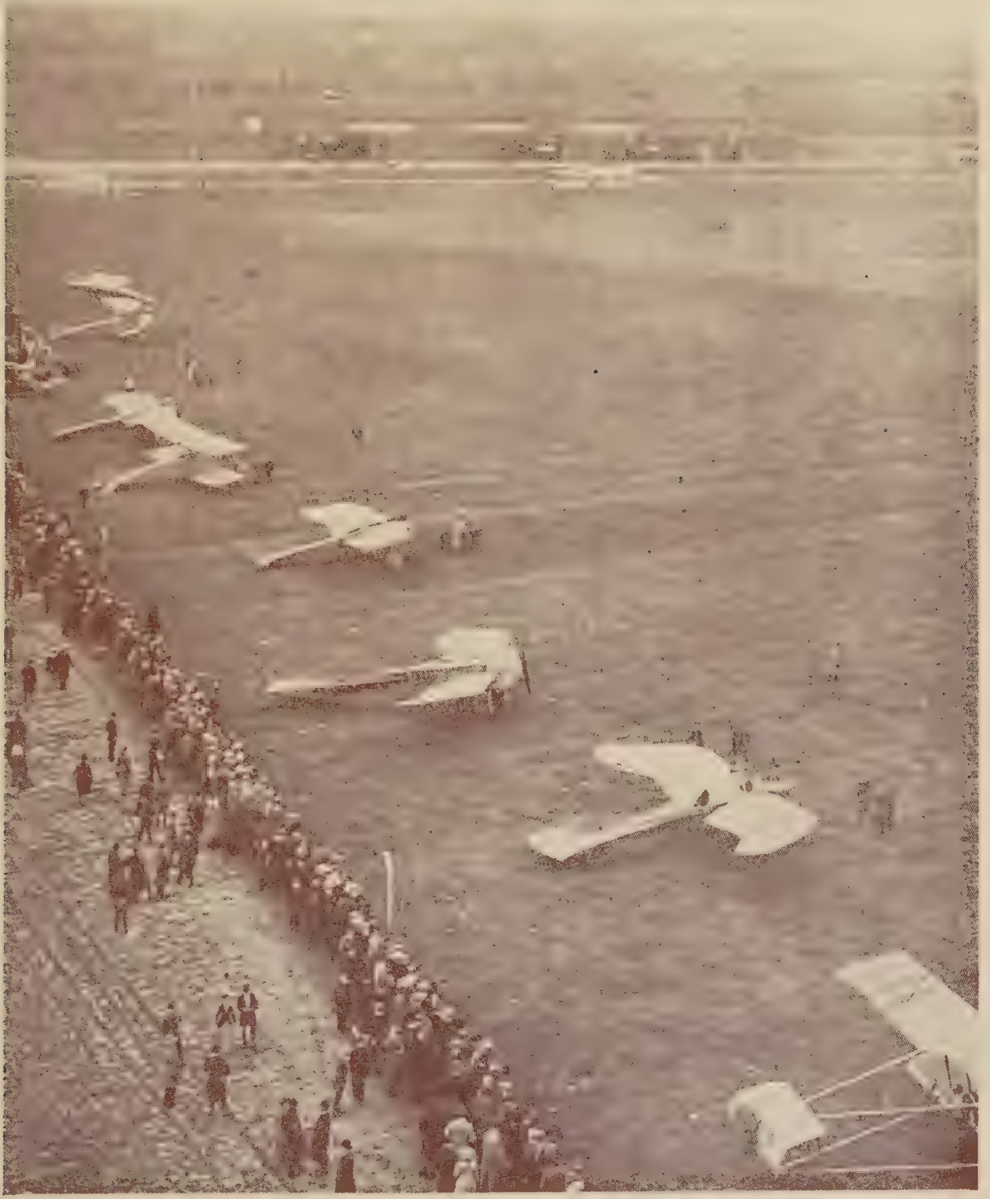
Very often such combats were fought amidst a welter of shrapnel sent up by the " Archies " barking noisily on the ground far below.

Some pilots developed such prowess in aerial combats that they gained world-wide fame by the number of their successes. For a time they would seem invincible. But it is a curious fact that whenever one of these super-airmen had some half a hundred victories standing to his credit his luck seemed to change. Captain Ball, Captain Guynemer (the Frenchman), Immelmann and Boelcke (Germans), and other notable champions, all met their deaths soon after they had brought about fifty opponents down.

Better fortune attended Lieut.-Colonel Bishop, V.C., D.S.O., M.C., D.F.C., the brilliant Canadian pilot, who at nineteen years of age had defeated forty-five airmen—a wonderful record—and afterwards brought his " bag " up to seventy-three. From the Canadian Mounted Rifles he transferred to the then Royal Flying Corps, and in the early part of 1917 was promoted to Flight-Commander. So formidable an opponent did he prove that the Germans put a price on his head, in the hope of getting rid of him.

The exploit by which he won the V.C. may be related, as showing the kind of stuff of which the modern knight of the air is made.

Starting off from the Western Front one morning, in the spirit of a hawk looking for prey, Bishop sighted a German aerodrome with seven German machines ranged on it, all ready to leave on a foray. " Here's my chance," thought he, and at them he went. Swooping close to the ground, he opened fire with his Lewis gun at the machines and thus set up a rare commotion. Taken aback though they were by this bold assault, the Germans nevertheless resolved that the raider should not have matters all his own way. " Surely seven can master one," thought they, and prepared to go after him. As the first of their machines left the ground Bishop poured a full broadside into



[*E. N. A.*

A SQUADRON OF TAUBES AT A GERMAN AERODROME.

it, and back it tumbled, a hopeless wreck. Turning his attention quickly to another enemy who was rising into the air, Bishop peppered him severely with bullets and chased him round until he crashed into a tree. That finished number two. Two others sprang up like flushed partridges and in a few seconds Bishop was after them. As they climbed he climbed also. Coming up with the first, Bishop opened so hot a fire that the foe could not stand it and fled incontinently. Swiftly the gallant Canadian turned on the other, slipping a fresh tray of cartridges into his gun as he tore at him. Closing in, he concentrated a terrific fusillade upon his opponent, who, overwhelmed by the leaden hail, crashed down like a stone. Seven enemy machines attacked, four accounted for—not a bad morning's work! Bishop was content for the time and flew cheerfully home.

But this was only one of many great deeds performed by this daring airman. Once he fought three Albatros scouts single-handed, and probably in all his adventures never experienced a more exciting time. Bullets whizzed past his head, and cut to and fro through his machine with sinister whine, as his foes tried to get round him. By marvellous dexterity in manœuvring Bishop defeated their plan. Seeing an opening at last, he drove boldly in and gave them all there was in his gun. Over went one of the Germans, spinning helplessly earthward; the others turned tail, leaving Bishop in victorious possession.

On another occasion he saw a comrade hard pressed by five Germans. Bishop without hesitation threw himself vigorously into the fray, using his Lewis gun so deftly that two enemy machines were promptly brought down. This was enough for the remainder, who made for home with all possible speed. It was Bishop who started the trick, which later in the War became common, of pouncing from the clouds upon German troops, spraying bullets among them with deadly effect, then bolting again before the bewildered enemy had recovered from their surprise.

Only in rare cases did the Air Service publish names. Successful actions were generally recorded without any clue to the identity of the men who won them, and thus *esprit de corps* was heightened. Owing to this system we do not know the names of the five heroes who, on May 5, 1915, fought and conquered twenty-seven German machines. But the details of this wonderful battle 'twixt earth and sky none the less make an intensely stirring narrative. It was a hot, misty day when the five stout-hearted Britons came to grips with the enemy air-fleet. The Germans were flying in three formations—that is, three separate squadrons—and were thus able to close in all round upon the intrepid five who, without breaking their order, immediately went for the foes nearest to them. The battle began at about 11,000 feet. From that it varied in altitude between 12,000 and 3,000 feet, as the machines spun about, now climbing, now diving, to gain the best attacking positions. And all the time German "Archies" continued to thicken the air unpleasantly with "woolly bears" and shrapnel. With the exception of their leader, all our men were comparatively new hands at the game, but they played it superbly. From 5 until 6 p.m. this extraordinary fight went on, and an hour is an unusual time for such an encounter to last amid the vicious shriek of anti-aircraft guns which make the scene of it a very inferno. The first success fell to the leader of the indomitable little British force. Grappling with a German plane, he poured into it such a skilfully directed stream of bullets that the foe sank earthward in flames. Immediately afterwards two other enemy machines were hurled to destruction. Then one of our men got into difficulties. His engine failed and his machine dropped like a stone. Quick as thought, a German was after him. One of the British pilots saw what had happened. Down he plunged upon the foe, like a kestrel striking its quarry, and destroyed him. Just then the failing engine picked up again and the British pilot shot back into the *mêlée*. But bad luck befel another of our fighters. His petrol tank burst into flames and forced him to retire. In air war an unwritten law decreed that an opponent whose machine has caught fire should not be attacked. But the Germans forgot all the rules of chivalry. One of them struck at the burning machine and

[*Illustrations Bureau.*

CAPTAIN BALL V.C., D.S.O. (TWO BARS), M.C.

This famous British airman had brought down 47 "officially recorded" enemy machines at the time of his death in May, 1917, besides many others as to which absolute certainty was impossible.

was repaid for this infraction of air-law by being promptly smitten dead himself; whilst the British pilot got safely home with his plane little better than a mass of charred framework. Those left in the air kept on with this exciting "scrap" until three more foes had been disposed of. By this time the Germans, despite their far greater numbers, were hopelessly routed and beat a hasty retreat.

The "conspicuous gallantry and skill" that gained the Military Cross for Capt. L. R. Aizlewood included an experience calculated to test the quality of the stoutest nerve. Whilst flying over the war-devastated stretch usually spoken of as "No-man's Land," Capt. Aizlewood descried five machines making towards him and knew them for Germans. Sending his 'bus heavenward, he waited until the enemy were directly beneath, then made a swoop. Approaching to within a few yards of the foe he had marked for his prey, the Captain loosed the full force of his gun. Over went the enemy, literally shot to pieces, but Captain Aizlewood was descending with such fearful speed that he could not pull up his mount in time to prevent a collision, and plumped right upon his disabled foe. Very seldom does either survive when two aeroplanes thus crash together in the air, and the heroic captain must have thought the end had come for him. Still, he did not lose presence of mind. Part of his propeller broke away; and then his machine wrenched clear of the entanglement. How much damage the machine had suffered, or when it would collapse utterly, the Captain did not know. Yet he kept his head, and, steering for the British lines, brought all that remained of an almost unmanageable biplane safely home.

Of sheer, dogged pluck one could not easily cite a better example than that of Major Brabazon Rees, one of our airman V.C.'s and also a wearer of the Military Cross. His record is an exceptionally fine one, as an episode or two from it will prove. In September, 1915, he fought a strenuous duel with a big German battleplane, which was twice as heavily armed and much more powerful than his own machine. Of this the Major recked nothing. Getting well above, he darted down upon the German, into which he rattled bullets so viciously that the enemy retired, "out of control." On another occasion Major Brabazon Rees fought a big German plane for nearly an hour until his ammunition had run out. Whereupon he flew to his aerodrome, loaded again, and, hastening back, reopened the fight, which he kept going hotly until he had crumpled up the foe. These

M. PEGOUD, THE FAMOUS FRENCH AVIATOR, WHO WAS THE FIRST MAN TO "LOOP THE LOOP."

achievements show the mettle of the man, though they are dwarfed by comparison with the thrilling feat by which he won the V.C. Whilst scouting along the British Front, he fell in with about half a score German aeroplanes. Tackling the leading one, the Major wheeled round and round it until he shot it down. Five others promptly made at him. Three he drove away, but still the others came on, firing as rapidly as they could. A tornado of bullets struck his aeroplane, damaging it badly. Worse still, one found its billet in the intrepid Major's thigh, inflicting a serious wound. Under this terrific assault his machine dived earthward, seemingly to sure disaster. But, though bleeding profusely from his wound, the Major pulled round again and headed straight for the enemy. Imagine their surprise at this temerity, imagine the situation of the Major, sorely wounded, engaging in his war-battered plane numbers whose mere weight should have crushed him. Straight in amongst them he flew, closing up until wings almost

[French Official.

THE "ACE OF ACES."

The famous Captain Guynemer, who at the time of his death on September 11, 1917, had brought down fifty-four enemy machines, besides many others the destruction of which could not be officially confirmed. On one occasion he managed to bring down two enemy aeroplanes in one minute and two more later on in the same day. Another gallant French aviator, Lieut. Fonck, brought down four machines in two minutes and two others on the same day.

touched, and in this position opened a hot fire, pouring into the enemy stream after stream of bullets until he had not a round of ammunition left. Only when the Germans acknowledged themselves vanquished did the gallant Major steer back to his own territory to have his wound attended to.

[*Illustrations Bureau.*

A FRENCH OBSERVER WHO HAS JUST DESCENDED BY PARACHUTE FROM A "SAUSAGE" BALLOON.

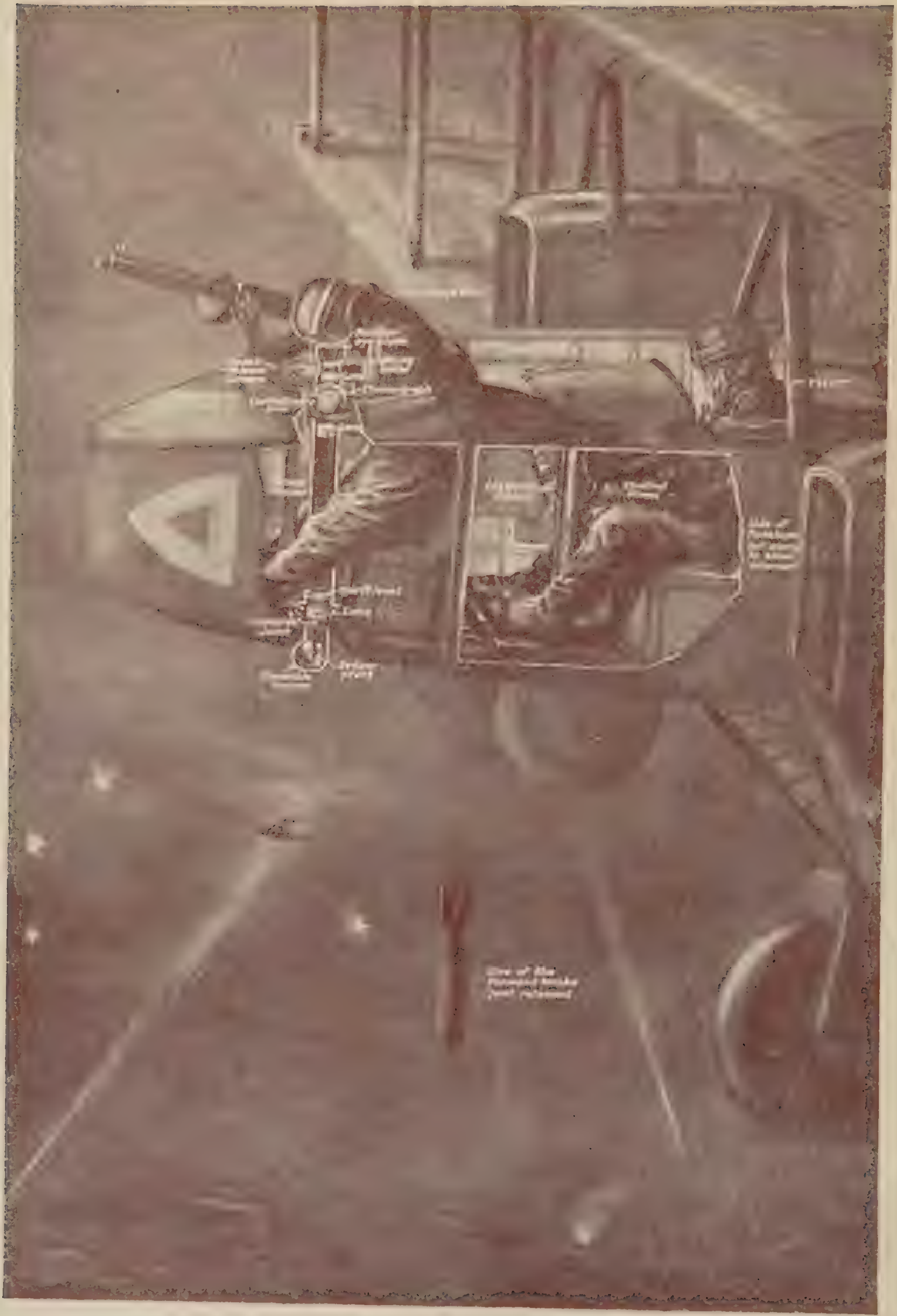
The worst plight an observer can find himself in is to be in the air with a badly wounded pilot. But observers can rise to an emergency as well as other airmen. While flying a battleplane in the Balkans, Lieut. Dunning and Second-Lieut. Otley encountered a couple of enemy machines. A sharp, determined fight ensued, in the course of which there was much manœuvring of the hair-lifting kind that happens only in these duels aloft. During a short exchange, when the combatants were hotly engaged at a high altitude, the British machine caught a full dose from the enemy's machine gun. Bullets fairly deluged it, with the result that the petrol tank was holed and the pilot dangerously wounded in the leg. Lieut. Otley, busy with his gun, did not notice what had happened until the enemy had turned tail. Looking then to the front of the machine, he saw that his pilot was badly hurt. Sitting calmly down, Otley improvised a tourniquet, which he passed to Dunning, giving him instructions how to use it. "Then we'll change seats," he added. Remember that all this time the machine, now a lame thing herself, was careering unsteadily, slipping up and down the sky. "First aid" service completed, pilot and observer changed places, the 'bus was pulled straight and headed for home.

But now another appalling trouble occurred. Out of the big hole punched in the petrol tank the "juice" was flowing so rapidly that unless the leak could be stopped there would be nothing for it but to descend, chancing where. Alighting in a mountainous and hostile country is an unattractive prospect, especially when you have a severely wounded comrade to look after. Otley quickly thought the matter over and liked it not at all. But how to avoid it? Bending forward, he pressed his thumb upon the bullet hole in the tank. The thumb stopped the waste perceptibly, so Otley kept it there, and steered the machine home safely, plugging the leak in the tank with his thumb all the way and "piloting" with one hand. An anxious trip it must have been under such conditions, with his pilot a bad casualty, and the imminent risk that some enemy "hawk" might sweep down on him at any moment. Well did he deserve the Distinguished Service Cross which was conferred in recognition of this achievement.

J. J. B.

THE TORN BUTTERFLY. [*British Official.*

The tattered wreck of a German aeroplane brought down in Flanders.



A GOTHA DROPPING BOMBS.

To allow for the time occupied by the fall of the bomb (which of course depends upon altitude and weight and to some extent upon wind) the missile is always discharged before the machine is over the object aimed at. Allowance has also to be made for the speed of the machine. A movable prism fixed beneath the bomber to some degree assists his calculations.

[*French Official.*

AERIAL BOMBS IN MID-AIR.

This remarkable photograph shows seven bombs actually falling on to a German factory in Lorraine, from which smoke and flames are rising.

Aircraft and Aircraft Weapons in War

IN the days when Waterloo was fought, and long after that battle as well as before it, the great desire of military commanders in making their plans was to see what was going on "on the other side of the hill." Victory in battle depends largely on the bravery and discipline of the troops, but it also depends largely on the way in which a commander disposes his men, and in order to secure the best effect it is essential that he should know something of what his enemy is doing. Down to the end of the nineteenth century the only means of finding what the enemy was about was by the use of cavalry patrols and of information supplied by spies, and even with the best of such services the information could be only fragmentary.

Then came the aeroplane, and transformed the problem of observation. From its position high in the sky the aeroplane could give its observer a view of all that the enemy was doing, and, by means of the wireless apparatus with which his machine was fitted, the observer could signal back to his commander what he saw of the enemy movements.

That seemed a simple business apparently, but immediately the aeroplane came into general use in warfare difficulties grew. Both sides had their fleets of aeroplanes, and, as flying developed, both sides conceived the idea of building "battleplanes," intended for fighting rather than for observation, and designed to keep hostile observers out of the sky and to prevent them from observing movements of troops. Another difficulty that came into being was that of anti-aircraft gunnery; at the beginning of the great War there was so little of this and so little experience in aiming at aeroplanes, that a height of 5000 feet was considered quite safe for flying men on observation duty. But as the War progressed anti-aircraft guns were improved, and airmen were compelled to fly at increasing heights—a man who then tried in clear weather to fly over the enemy lines at a height of 5000 feet, would almost certainly have been shot down, though the risk was often taken, especially during great battles. For safety, the airman had to fly at anything between 10,000 and 18,000 feet.

This, again, complicated his work. While flying at 5000 feet, which is a little less than a mile above the ground, he could see fairly well what was going on beneath, but when he had to go up two miles and more in order to be beyond the reach of "Archies," as the anti-aircraft shells were called, he could see only the most vague and general movements of the enemy, and might easily be mistaken or deceived. So the

[E. N. A.

A FRENCH MILITARY AVIATOR WITH MITRAILLEUSE.

[*Alfieri.*

AN EARLY DEVICE FOR CARRYING AND RELEASING AERIAL BOMBS.

photographic camera came in, for, properly used, it is more reliable at long distances than the human eye. So that now, among the weapons of the airman must be included the photographic lens, with which he takes pictures of trench systems, enemy formations, lines of communication, the results of bombing raids and, in fact, of all that lies beneath him.

At the beginning of the War the main requisites of aeroplanes were speed and climbing power; and, since the work was simple compared with what it became later, if a machine was satisfactory in these two respects it was considered a good war machine. But, as flying developed for military uses, it became necessary to build special machines for different purposes: single-seater or two-seater scouts, very fast and armed only with a machine gun, served for photographic expeditions. Since the enemy would certainly send up bigger and better-armed machines to stop these scouts from working, it became necessary also to build fighting aeroplanes which could escort the scouts and drive off the machines that tried to interfere with them. This fighting machine would necessarily be bigger and more heavily armed than the scouting aeroplane—it might carry two or more gunners in addition to the pilot. Then, again, it was found that much trouble for the enemy could be made by bombing and blowing up railways and roads behind his lines, so there came into existence bigger machines still, specially designed to carry large loads of explosives, which might be dropped on railways, stations and sidings, encampments, and the like. And since these big machines, heavily loaded, could not fly and manœuvre quite so quickly as the

A WHITEHEAD FIGHTING SCOUT.

fighting planes, it was found necessary to send with them on their bombing expeditions an escort of battleplanes.

Taken as a general rule, there were three distinct kinds of aeroplane for war use. There was the speedy little scout, which was used for observation of enemy movements, photographic expeditions, and for directing the fire of artillery—for this last use it hovered and circled over to the front of the guns, signalling back to the gunners the result of their shots on the enemy lines. Then there was the battleplane, which kept off enemy aeroplanes, attacked enemy scout machines and prevented them from making observations of our own lines, and was, as a whole, designed for fighting pure and simple, though its pilots and gunners managed to get in a lot of useful observation work as well, and very often the battleplane carried a camera and photographer as well as pilot and gunner. Lastly there was the big bombing machine, usually fitted with a machine gun or two, and generally with twin engines, often with two propellers instead of the one that drives the scout and the smaller sort of battleplane.

The flying man fits his weapons to the work he has to do, for it is impossible to fit out a machine so that it can serve any and every use. At the same time an airman must be quick to turn to his own advantage any unexpected development while he is up. But supposing his particular job were that of " spotting " for the guns—that is, directing the fire of the artillery by signalling where their shells fall ; in that case he would go up as a rule armed with a machine gun, in order to engage and drive off any enemy who might attack him. If the weather were hazy, he might have to fly low and to risk the " Archies," and many an artillery observer, when thus flying, turned his machine-gun to good use by firing into the enemy trenches as he passed over them, thus causing panic among the men. For anyone who has seen active service will tell you that nothing is so demoralizing, nothing produces panic so quickly, as being fired at from the air, Cases were recorded where a single small machine, with its gun properly used, put a whole battalion to flight. It was often useless for the men in the trenches to fire at the airman, for he was travelling at a speed of something like a hundred miles an hour, and trying to hit him was like throwing stones at a swallow, though machine-gun fire was often very effective.

Again, when a machine set out on a photographic expedition over the enemy lines, it was armed with a machine gun for purposes of defence, and generally carried a few bombs as well. If, when well over the enemy lines, a suitable target—a body of men on the march, a troop or ammunition train on a siding, or a road convoy of military supplies—was observed, two or three bombs were dropped, often with good effect, though the real business of that particular machine was the taking of photographs, and not bombing at all.

When photographs thus taken were brought in and developed, they were passed on to a department that placed them in their proper order, side by side, and from them built up wonderful maps that showed every detail of the enemy trench system, the roads and the light railways behind his fighting front, and all the details of the work he was doing. In the old days cavalry patrols could only bring in rough reports of what was being done in a small section of the enemy formations; the aerial photographers brought back

[*Whitehead.*

FIXING THE GEAR BY MEANS OF WHICH THE FIRING OF THE MACHINE GUN IS MADE TO CORRESPOND WITH THE REVOLUTIONS OF THE PROPELLER BLADES, THUS ALLOWING THE BULLETS A FREE PASSAGE.

to their corps commander exact details of the whole of the enemy lines and works.

When a bombing raid was planned it was usual to send not single machines, but three or more "flights," a flight consisting of four or five machines. In some raids forty or fifty machines were used, and even bigger formations are possible. Each of the big bombing machines was given a load of bombs, so placed that the man responsible had only to press a trigger, as with a gun, to release each bomb in turn and let it fall when the time came. If the place to be bombed was small, such as a railway station, a submarine dock, an aerodrome, or an ammunition "dump," the formation of the machines was so arranged that they passed over their target one after another, each dropping its bombs as it went. Meanwhile the fighting machines that accompanied the bombers engaged any hostile aircraft that were sent up to stop the raiders, and often one or two of the raiders would be detached from the main work in order to drop bombs on to anti-aircraft gunners, in order to prevent them from firing while the raid was in progress.

It is common knowledge that aiming projectiles from an aeroplane is a difficult task. After it has been released the bomb describes a parabola (a term which every boy who has begun the study of geometry will understand) and will strike the ground some distance ahead of the point above which it was dropped. Just where it will fall is decided by the speed at which the machine is travelling, the force of the wind, the shape and weight of the bomb, and so on. Absolute accuracy of aim in these circumstances is very difficult. Midway through the War it was found that the Germans were using a very ingenious "sight" in some of their battleplanes. This instrument consisted of a telescope hung on gimbals and pointing downward through the floor of the machine. When the sight was correctly set the fact was shown by a spirit-level so arranged that the pilot could see the "bubble" reflected in the telescope whilst he was aiming and thus alter it so that the movements of his plane did not throw him off his target. Distance was measured by means of fixed prisms, and the bomber could thus tell not only when he was "on" his target but also how far he was from it, and thus judge his delivery. But even with such an appliance accurate aiming is possible only in fine weather, when there are no varying air currents to deflect the falling missile. From this it will be seen that although bomb-dropping is never likely to attain the deadly accuracy of artillery fire it is far from

A SCOUT CIRCUS:
A Flight of Scouts looking for Trouble.

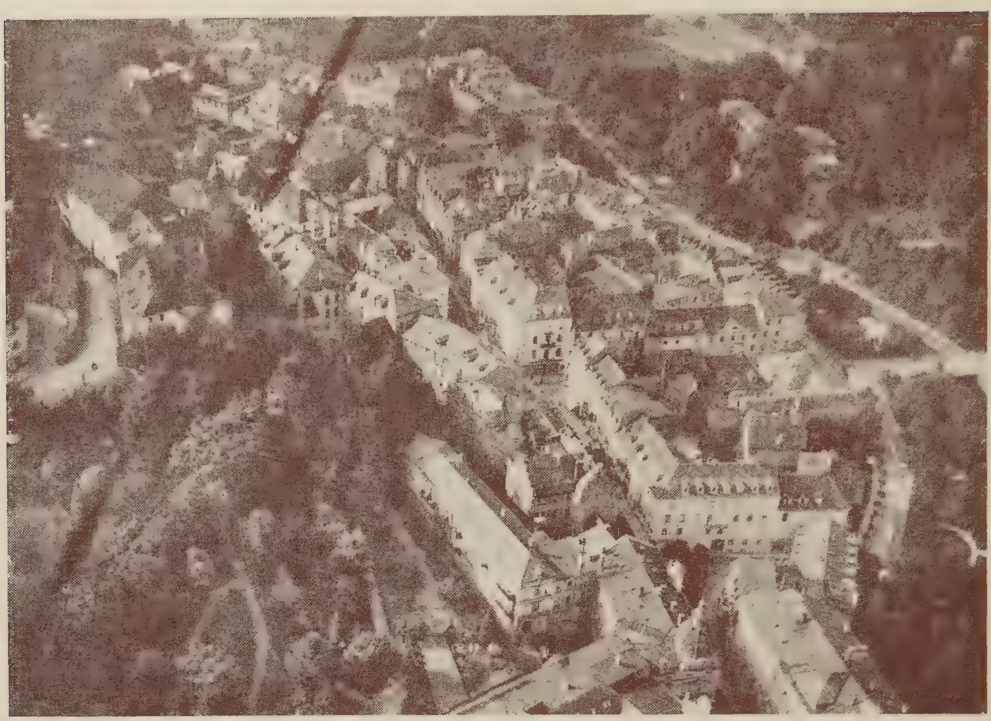
being the haphazard proceeding it used to be when airmen simply threw out missiles by hand and chanced where they would fall.

The use of aircraft soon gave rise to a system of concealment of guns, troops, ammunition dumps, and military stores in general. This system was generally known by the French word *camouflage*. Batteries were concealed by branches of trees thrown about with apparent carelessness; big stacks of ammunition had branches of dead furze thrown over them, and aeroplane and airship sheds were painted in patches of different colours, so that they corresponded with the varying colours of the ground near them. These are only instances of *camouflage*, and poor instances at that, for some of the devices used for concealment from prying aircraft were very clever indeed, and as simple as they were clever. When one is on the ground, one can see quite clearly what such devices are, and sometimes when thus viewed on the level they look almost foolish. But all the same they afford almost perfect concealment.

Aeroplane gunnery is in process of development from the mere carrying of a Lewis machine gun up to making the aeroplane practically an artillery platform. For attacking other aircraft, the Lewis machine gun proved very effective, for though it only fires an ordinary rifle bullet, it can spit out a steady stream, and if only one bullet strikes the pilot of

[Illustrations Bureau.

A MONSTER BRITISH BOMB FOR USE IN THE EAST.



[*Farringdon Photo Co.*

A TOWN PHOTOGRAPHED FROM THE AIR.

the other machine it is generally the end of the fight, while should one penetrate the petrol tank there is a good chance of setting the machine on fire. The larger aeroplanes of recent design carry rapid-firing guns of heavier pattern, throwing inch and two-inch shells, so that the gun may supplement the work of the bombs against large targets, for explosive shells of two-inch calibre can do a great deal of damage, especially when used against anti-aircraft gun crews. On some machines the gun is fixed—this is more usual on the small scouting machines—and the pilot has to aim the whole aeroplane in order to aim the gun, which either has a simple mechanism attached to it to prevent the shots from hitting the propeller blades or else fires through the hollow propeller shaft. On other machines the gunner sits inside a ring that carries the gun, and the ring itself can be swung round so that the gun is pointed to any degree of a circle that may be required.

In addition to machine guns, fighting airmen usually carry automatic pistols. Indeed, some of the most thrilling fights of the War were waged by men whose guns had jammed and who then closed in on their opponents and blazed away with their automatics. But this, like the aiming of a machine gun from an aeroplane, requires perfect nerve and very rapid decision, for when two aeroplanes are passing, each travelling at a hundred miles an hour or more, there is not much time for aiming or for thinking just which is the best point to hit—the thing has to be done in a flash, and then you are past the enemy machine and swinging round to be ready to meet him when he comes into range again.

The fighting pilot of to-day must not only know how to fly his machine, but he must be so trained that he can use his gun to the best advantage, and drop his bombs with a knowledge of where the speed of his machine and the wind will carry them before they reach the ground. Either he or his observer must have a very good knowledge of photography, and be able to work whatever signalling apparatus is fitted to the machine. There are, indeed, a hundred things that a pilot must learn before he goes up within reach of an enemy.

"NO DAMAGE!" (GERMAN OFFICIAL). [*Newspaper Illustrations.*

A German railway station photographed after a raid by Allied airmen.

There was little difference during the War in the work of the naval pilot and the military pilot, except that the former was sailor rather than soldier. He had to be expert at spotting the submarine beneath the water; the higher he was, generally speaking, the easier for him to see a submerged vessel. His work involved more scouting than that of the military flyer, and the covering of greater distances, but he had also to engage in bombing raids on enemy bases, in which case his work was the same as that of the military pilot. He, too, needed be an expert machine gunner, and good at working the wireless apparatus which reported to the warships what he had seen.

And, whether naval or military, it was part of the duty of both the air pilot and the observer to be ready at an instant's notice to give their lives in the service of their country. The records of the Royal Air Force prove that no more gallant body of men has ever been got together for service on land or sea.

Illustration Bureau.

A FRENCH AEROPLANE DESCENDS IN A PARIS STREET.

Although the machine was completely smashed, the airman escaped with a few bruises.

[Illustrations Bureau.

THE R 34.

The great British airship which made the famous double journey across the Atlantic in July, 1919.

Airships and Balloons

THE exponents of true flight have always been rather inclined to smile at students of the dirigible,[1] or lighter-than-air craft, whom they term the "gasbag school," since the dirigible owes its lifting power to the gas it contains, and not to any wing area or driving force. The War greatly helped the aeroplane, and perfected its design at a very rapid rate; at the same time War, by exposing the defects of the dirigible from a military point of view, arrested its development. It would be wrong, however, to say that the War killed the dirigible, for the needs of Peace are different, and it is more than likely that the "gasbag," probably in a different form

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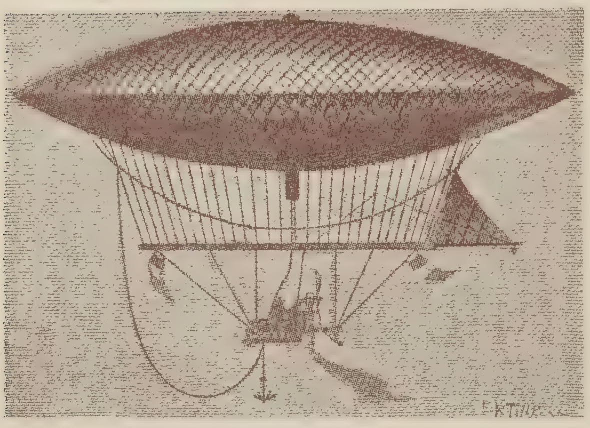
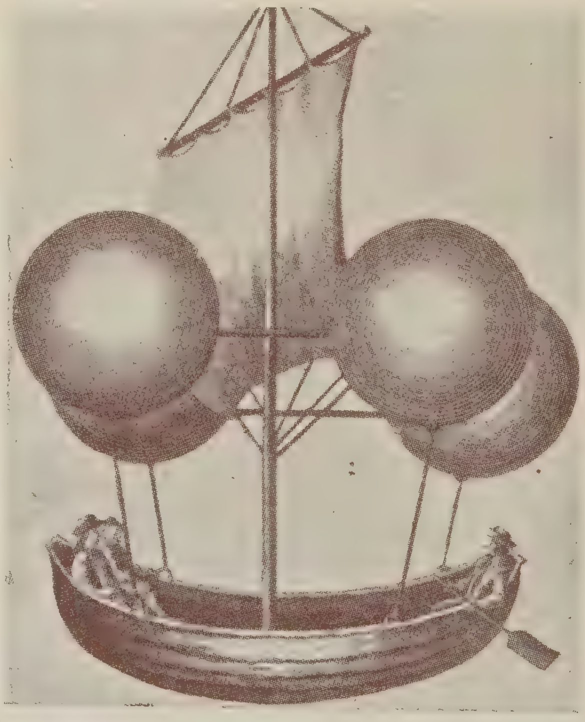
[1] Derived from the Latin word *dirige*, to "direct or steer," as in the well-known motto of the City of London, *Domine Dirige Nos*, "Lord direct us."



GIFFARD'S STEAM DIRIGIBLE, 1852.
A speed of six miles per hour was made.

from that which we know now, will take a very large place indeed in commercial aeronautics before many years have passed. In developing the aeroplane for War the chief points studied were means of offence and defence; for commercial utility the chief considerations are power, cost and durability—totally different problems. And here the dirigible scores heavily.

Its possibilities were realized in the seventeenth century by one Francesco Lana, a Jesuit monk, who designed, but never constructed, an "aerial ship." Basing his design on the fact that, as you increase the size of a sphere, you increase its capacity twice as fast, Lana suggested that spheres of very thin copper should be constructed, and the air pumped out of them, when, being lighter than the surrounding air, they would rise, and, if they were made big enough, would not only rise themselves but would lift men with them. This was long before the balloon came into being, and it was not until after the balloon had been invented that a Frenchman tried to carry out Lana's idea. But he found that when the copper globes had been made sufficiently thin to exercise



LANA'S DESIGN FOR AN AERIAL SHIP (17TH CENTURY).
The idea was to lift the ship by means of thin copper balls from which the air had been pumped, an idea which led, later, to the balloon.

lifting power they were too fragile to stand the pressure of the outer air when the air was pumped out of them, and they went into the melting pot. The idea was good in theory, but it would not work in practice.

Three-quarters of a century ago, or thereabouts, another Frenchman, M. Giffard, designed and made the first dirigible balloon. It was much like the "Parseval" type of dirigible used in the early days of the War, but a little more bulged in the middle, and it was fitted with a steam engine of three horse-power, which drove a propeller of 11 feet pitch. The balloon itself was over 140 feet in length, and nearly 40 feet in diameter, so that to the people of those days, who had never dreamed of more than the ordinary spherical balloon, it must have looked a monster. It made a number of trips, and attained a speed of six miles an hour, being perfectly under control. The drawbacks attendant on the use of the steam engine, however, prevented this first dirigible from getting beyond the experimental stage. Giffard proved that the navigation of the air could be accomplished, given a suitable engine, and there the matter rested.

THE FIRST CROSSING OF THE CHANNEL BY AIR, JANUARY 7, 1785.

The balloon, piloted by M. Blanchard, with Dr. Jefferies as a passenger, left Dover at 1 p.m. and descended at Guignes, in France, just before 3 o'clock. By order of the King a pyramid was erected on the spot. M. Blériot first crossed the Channel by aeroplane on July 25, 1909.

TRAINING OBSERV

The spherical balloons so often seen over London during the War were used for training officers, though ma

OR THE ROYAL AIR FORCE.

ople supposed that they played some mysterious part in defending the Metropolis against hostile aircraft.

The next prominent exponent of this type of craft was Albert Santos-Dumont, a Brazilian who, in the "nineties" of last century and the first decade of this, did as much as any man to develop the science of aeronautics. He began his experiments in 1898, and in all built nine dirigibles, with which he made hundreds of flights, persevering in improvement of design and startling the world with his successes. Later, he turned his attention to the aeroplane and its development, but it is in connexion with his series of dirigible airships that his name is best known.

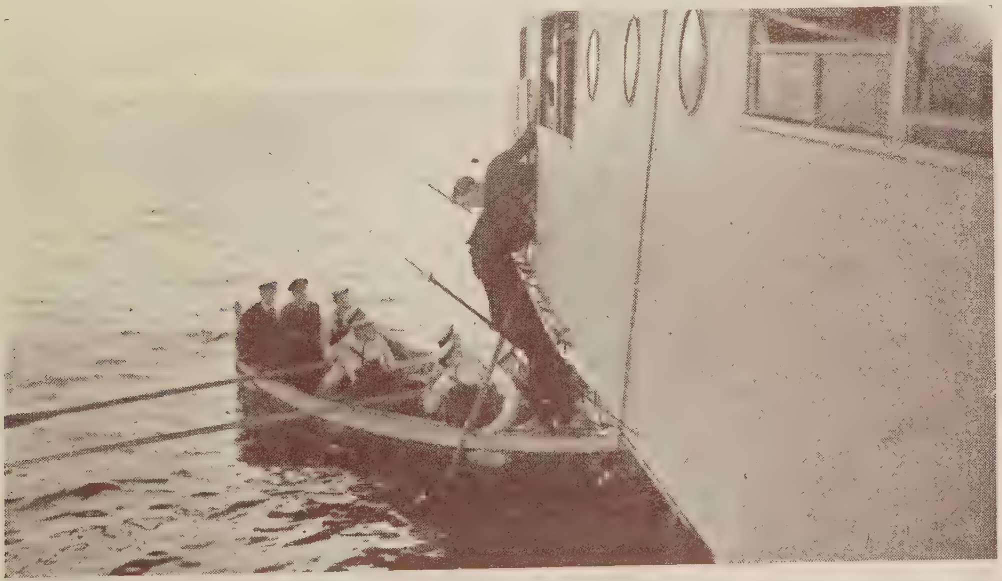
One man, who was subsequently to acquire greater fame than Santos-Dumont, watched his experiments very closely. Ferdinand von Zeppelin devoted five years to experimental work, striving to perfect the rigid dirigible, in which the gas-bags are contained in a framework which makes the vessel a perfectly rigid structure. On July 2, 1900, Zeppelin's first dirigible was launched over Lake Constance. It had a framework of aluminium, divided into seventeen compartments, which were occupied by bags filled with hydrogen gas; it was over 400 feet in length, and nearly 40 feet in diameter, of the shape and type that afterwards became only too familiar to English people. At the time this first vessel of the Zeppelin type was launched, its inventor was sixty-two years old, and, though the vile uses to which the Zeppelin was put have since made his name infamous, he had incredible perseverance as well as great inventive genius. He designed a passenger service of airships; the last of his passenger-carriers of which details are available was launched in 1913, with sufficient lifting capacity for over thirty passengers, with a cabin and restaurant service, and with engine-power for a speed of fifty miles an hour, which could be maintained for forty hours without a stop.

It is doubtful when von Zeppelin ceased to control these airships and the German Government stepped in, but it is certain that before the Government took a hand Zeppelin had sunk all his own money in his invention. Storms and bad management of the earlier airships brought about a series of wrecks, but Zeppelin went on building and improving, until the German military authorities realized that here was a mighty weapon for the war they had planned. Long before the last passenger-carrying vessel was launched, the passenger flights had become mere experiments with a view to determining the military possibilities of the Zeppelin airship, and at the outbreak of War every one of these vessels was taken over for naval and military service.

Alfieri.

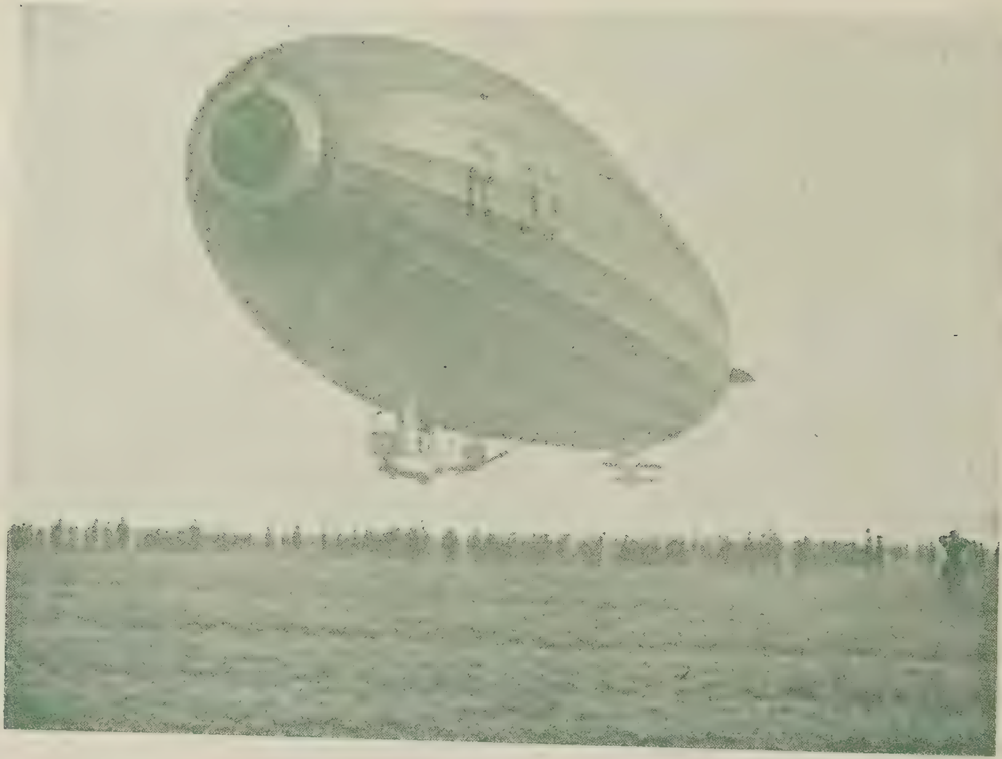
A NAVAL "S.S." (SUBMARINE SPOTTER), COMMONLY KNOWN AS A "BLIMP," DROPPING A DUMMY BOMB

These useful little craft are very fast and easily controlled. During the War they did excellent service in many parts of the world, and especially round our own coasts.

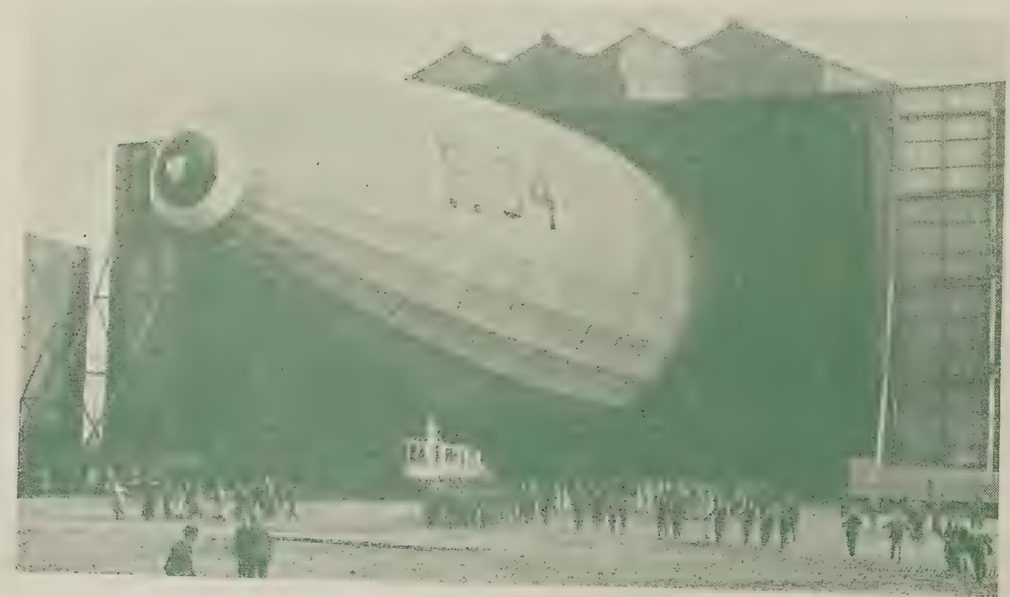


[*British Naval Official.*

A BRITISH NAVAL AIRSHIP DESCENDING TO THE SEA TO TAKE UP AN OFFICER FROM A SHIP'S BOAT.



THE R 33. [*Illustrations Bureau.*



THE FAMOUS R 34 BEING TOWED OUT OF HER SHED. [*Illustrations Bureau.*

EARLY BRITISH ARMY AIRSHIP, BABY I. [*Topical Press.*

SPHERICAL BALLOONS AT HURLINGHAM.

A DESCENT BY PARACHUTE FROM THE TOWER BRIDGE.

The value of the parachute as a means of life-saving depends largely upon the height from which it is used. Contrary to general impression, a drop from a great height is much less risky than a short descent. This fall was considerably under 200 feet. The demonstration was held to show the value of the Calthrop "Guardian Angel" parachute.

But all this does not detract from the scientific value of Zeppelin's work. He perfected the rigid type of airship, and in all probability the world will eventually profit from his designs, which make possible many things such as a Transatlantic air service and the transport by air of heavier burdens than even the largest aeroplane can cope with. In the matter of speed the aeroplane will always retain superiority, but for peace uses speed is not the chief consideration, as it is in war.

It is a far cry from the silken bags that the Mongolfier brothers sent up, inflated with hot air, in 1782, to the rigid dirigible of the Zeppelin type, or to

NEARLY DOWN.

THE PARACHUTE RESTING ON THE WATER. THE PASSENGER IS QUITE SAFE.

the French Lebaudy semi-rigid dirigible, or the Parseval and Clement-Bayard non-rigid types, but even these can be considered only as half-way along the road to perfection. They are all fragile and dependent on the state of the weather and the atmospheric pressure, though not so much so as is generally supposed, for it was officially recorded that during 1918 there were only nine days on which no airship flight took place in the British Isles. In crossing oceans and deserts, and for long journeys generally, the dirigible "gasbag" is, and will probably remain, superior to the aeroplane, so long as it is not required to defend itself from attack or to escape attack by flight. Already one has remained in the air for four consecutive days, travelling over 6,000 miles meanwhile.

[*French Official.*

FRENCH ANTI-AIRCRAFT GUNNERS RELEASING A SMALL BALLOON TO TEST THE DIRECTION AND STRENGTH OF THE WIND.

Quite apart from the airship controlled by engines and propellers, the "kite-balloon" is a form of lighter-than-air craft which has

A COAST PATROL AIRSHIP SENDING A DESPATCH BY MOTOR LAUNCH.

been used in war for many years. Its useful work is described in a separate article. The chief task of the kite-balloon is "spotting," or observing heavy artillery fire, and correcting the aim of the gunners. Balloons for military purposes first came into prominence during the Franco-German War of 1870–71, when, in addition to using captive balloons, the French, during the siege of Paris, established an aerial post by means of balloons.

Yet another use of the "gasbag," apart from the dirigible, is that of making observations of the upper air. Small balloons, fitted with all sorts of recording instruments, are sent up—without passengers, of course—and their fall is traced, when the instruments that they have carried give particulars of temperatures, pressures, air currents, and the composition of the air at heights which man himself has never been able to reach. The highest flight recorded either by balloon or aeroplane is somewhere about five miles above sea-level, but the little balloons sent up for observation of the higher levels reach immense altitudes, and by their use it has been ascertained that the proportions of the various gases which make up the air we breathe are greatly changed at heights over six miles. Also the thickness of the air envelope in which the earth is wrapped has been more correctly estimated, though even now there is no definite knowledge as to how far from the earth the atmosphere extends. Before such observations were taken it was thought that air only extended about twenty miles from the earth, but it is now believed that it may extend for five times that distance or more.

The composition of the air is a fascinating subject, more especially of its upper layers. For one thing, it is probable that there is, at a great height from the earth, a layer of inflammable gases, which would partly account for the blaze of a meteor when it enters the atmosphere. The existence of such a layer is rendered more probable by the fact that the earth is continually throwing off inflammable gases which, being light in comparison with the air we breathe, would rise in just the same way as a balloon, and would float on top of the ordinary air just as oil floats on water. It may be that these lighter gases will yet be "tapped" and brought down to earth to be put to practical use; however that may be, the "gasbag" balloon, in various forms, will go on adding to our knowledge of the upper air and its component parts.

E. Charles Vivian.

AN AERIAL CRICKET MATCH OF THE FUTURE.

[French Official.

A FRENCH GENERAL CONFERRING DECORATIONS ON AVIATORS.

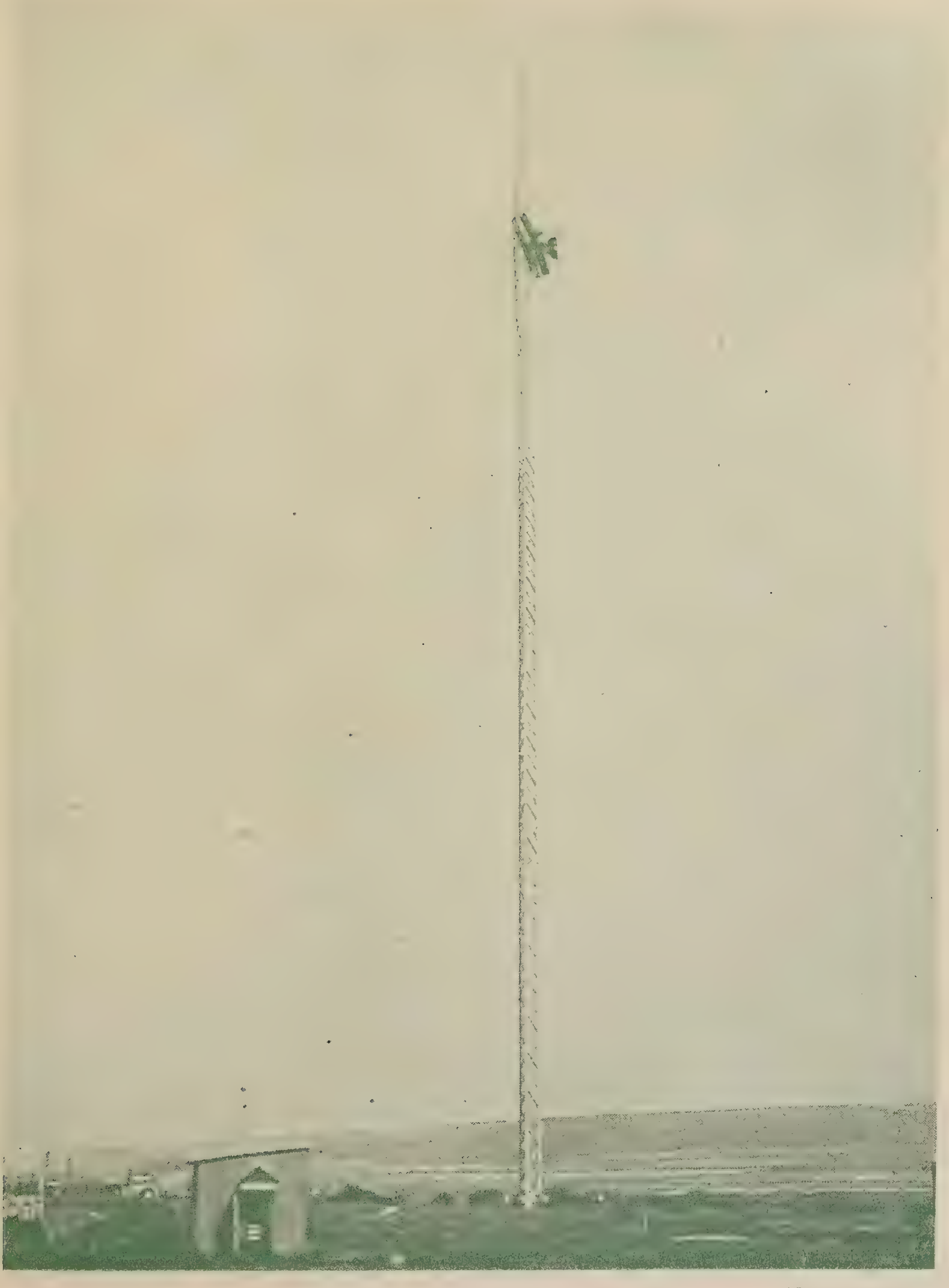
The Life Adventurous

MOUNTED on their steeds of wood and metal the airmen of the War sallied forth in true knightly fashion to seek adventure among the racing clouds, climbing through them to the snulit spaces above to find and to fight scouting enemy craft, daring countless dangers, and perhaps diving right down on to the trenches through a never-ceasing hail of "archies." Adventures there were each day in plenty, and some the most amazing.

Skirting the clouds on a sunny summer morning crept a British scouting aeroplane, the pilot keenly watchful for enemy craft. Suddenly he made out the shape of another aeroplane, apparently right in the middle of a cloud. Amazed and curious, he gave chase. But the enemy kept always the same distance ahead. More curious still, as he turned to the right the other craft followed suit. When he banked left, so did the other man. For almost half an hour the chase continued, until finally our man discovered that the supposed enemy aeroplane was the mirage of his own machine in the clouds!

Another pilot encountered a German battleplane in the region of 10,000 feet. The resulting "scrap" was fast and furious. Now the British pilot was on top, now the enemy. Getting between his opponent and the sun the former then dived down on to the German's back, firing rapidly the whole two thousand feet with his machine-gun. The enemy machine staggered and began to dive, then, as suddenly, steadied. Our man closed in, every moment expecting the end. But still the enemy kept flying round in ever-widening circles, apparently unaffected. Thoroughly alarmed, the British pilot rapidly fired two more trays of ammunition. The smoke died away and the Britisher eagerly searched the skies. The phantom machine had disappeared. Still wondering, he turned for home, when, five hundred feet below, the strange craft came speeding from behind a large cloud. Curious and indignant, the pilot closed in as near as safety would permit. With wing-tip almost scraping wing-tip, he peered eagerly into the cock-pit of the other machine. There, a huddled grey form, with an ugly red stain on his tunic, lay the German pilot, with a bullet through his heart. The machine had flown itself by means of a cunning arrangement of stout rubber bands!

Other startling adventures there were beyond count in the dark watches of the night, through lightning and hurricanes, or creeping through the shrapnel bursts on moonlight nights. War-flying is a ticklish profession, and, being such, it behoved a good mutual understanding among all concerned. It was team-work that counted, guaranteeing victory in the aerial combat that made possible the successful reconnaissance trip or photographic "stunt." The observer and the pilot had to work hand in hand, knowing each other's tactics and intentions, and ready on the instant for any novel situation. In this respect the British air service proved to be far in advance of that of the enemy. Even in the air the German is unable to forego rank and self-importance. An excellent instance of this was the case of an officer and a sergeant who set out one fine morning from the great enemy aerodrome at Ghistelles to make a reconnaissance of the British lines. About the time of crossing the anti-aircraft fire a shell struck the side of the machine, wounding the officer in the arm. Unaware of this, the sergeant, who was piloting, kept steadily on. Presently he was amazed to see the observer dancing in his seat, his face livid with rage, and making pantomimic



[British Official.

A DANGEROUS PERCH.

A British seaplane emerged from a cloud at high speed and struck one of the masts of a shore wireless station at a height of 300 feet and remained wedged in it. The pilot was rendered unconscious and thrown out of his seat on to one of the wings. From this perilous position he was rescued by three brave seamen, one of whom climbed out on to the plane, though both the damaged machine and the bent mast might at any time have collapsed, especially as one of the three supports of the mast was fractured. The Albert Medal was awarded to the rescuers.

gestures to him to take the machine down. This, however, was far from the pilot's intention, and at each renewed outburst he sternly shook his head. This proceeding served only to add to the officer's rage. He began to climb across the narrow space dividing his own from the pilot's seat; then, with a furious lunge, he grabbed the pilot by the throat. The ensuing fight was short but fierce. Now this way they rolled, then that; the machine meanwhile getting out of control and plunging downward. Finally, with a mighty heave the sergeant threw the officer overboard, and two minutes later the machine crashed in our lines.

On another occasion an enemy machine was brought down by our anti-aircraft guns. Immediately infantry surrounded the craft to make the crew prisoners. Only one man, the pilot, was to be seen. Presently, huddled in the bottom of the fuselage, the observer was discovered. Imagining him to be dead, they laid him reverently on the ground and covered his head. Judge of their surprise, when, two minutes later, the supposed corpse began to groan and writhe. Far from being dead, he had been blissfully intoxicated and had slipped off his seat in a drunken slumber. Forthwith, instead of congratulating himself on what was undoubtedly a record in war aviation, he began to revile his pilot in lurid language, the bone of contention being that he—the pilot—had not saved the machine and landed in the German lines!

At sea, flying is no whit less adventurous and is frequently even more exciting. Over the grey wastes of the lonely waters many a good fellow has flown off never to return. Somewhere beneath these cruel grey waves lay his battered craft, and his mutilated body would be washed up days later on the Channel shore. But this was never known to daunt the courage or the ardour of the gallant young fellows of the seaplane service.

Early morning in the Channel: a squadron of light cruisers and torpedo boats riding a glass-like sea. Over the scene lies a strange air of expectancy, as though all await some distant visitor. In the middle of the convoy lie strangely-painted vessels with a seaplane runway at each stern, and a great crane that leans far out from the deck over the water. The decks are alive with swiftly moving figures. Then through the mist of the eastern horizon come winging three black specks, the last far below the others and rocking and diving in an unnerving manner.

With a majestic sweep and a deep roar of their engines, the two leading machines land beside their parent ships, and the giant cranes swing them on board. Then the lagging craft comes fully into view. For a time it appears certain that she will plunge headlong into the water, but with a crash of splintered framework she contrives to land close to her ship. Aboard, the Commander is livid with rage at such a disgraceful exhibition. He hurries to the side bent on stern rebuke. The ship's company tremble in their shoes.

[*Canadian War Records.*

A BAD LANDING.

Forced to descend, this British machine only just missed slipping into the trench. "Landing" is always one of the airman's greatest difficulties, especially on broken ground such as this.

The wash of the sea brings the damaged seaplane nearer and nearer. But now the anger has died from the Commander's face and his expression is one of deep anxiety. For he has caught a glimpse of a bloodless young face and a shattered arm that hangs, red-stained and useless, at the pilot's side.

A THRIL

A damaged aeroplane has fallen on to the water. The pilot and observer are still clinging to the half-subm

CIDENT AT SEA.

chine when a seaplane comes to the rescue. By means of a rope both are hauled to the sea machine and saved.

As two marines carry the still form along the deck on a stretcher he catches sight of the Commander and apologizes faintly. "A bad landing, sir. Sorry. It shan't occur again," he promises fervently, so fervently as to bring a choking sensation to the Commander's throat, and to make him turn his head sharply to hide something suspiciously like mist in his eyes.

Twenty miles from home the pilot had been hit. Twenty miles from home, with but one arm available, he had kept up by a superhuman effort until his reconnaissance was completed, and now at the last he was genuinely heart-broken over his unfortunate and unavoidable landing! That is typical of the spirit of the service.

A British seaplane set out from a shore station to bomb a port where the enemy had accumulated a great store of aircraft and submarines; the one to fling death and destruction on helpless women and children from the skies, the other to sink defenceless merchantmen on the seas. Five bombs he had dropped on vital positions in the docks and aerodromes before being driven off by a violent anti-aircraft bombardment. One of the last shots winged him and brought him down on to the surface half-a-mile from the shore. Observing his helpless condition, all the heavy shore batteries trained their guns upon him. Luckily their marksmanship was inaccurate. In the midst of the clatter two French seaplanes appeared on the scene. Without hesitation, and despite the heavy shell-fire, one of these craft plunged to the Britisher's rescue.

Meanwhile the Germans had despatched all manner of aircraft and patrol boats from the shore. Frenchman No. 2 had his hands more than full in keeping them off. No. 1 had already come down alongside the British machine and, after considerable difficulty, had succeeded in taking off both the pilot and the wounded observer. Covered by the companion craft, he then made off in the direction of home.

Then, as if to pay the price of her courage and daring, patrol plane number two was in her turn brought down to the water. Her position was hopeless, the companion craft being already out of sight. But she put up a brave fight, and for almost half an hour kept the enemy off with her machine guns. Then, all her ammunition spent, her pilot and observer both badly wounded, she surrendered. But before doing so the gallant pilot released a carrier pigeon, with, attached to her leg, a long streamer, emblazoned "Vive la France."

Another story. Lieutenant F—— departed one night to raid a certain city. Over the place, in a blaze of bursting shrapnel and searchlights, he lost his engine and the machine dived nose-first for the earth. Imagining him to be beyond recovery, the Germans ceased to fire. Then, to their astonishment, at five hundred feet up he got the machine out, and made off homeward.

[*From L'Illustration.*

REPAIRS IN MID-AIR.

A mechanic has crawled along to repair the port motor of a French dirigible. The craft is well out at sea, spotting submarines, but whereas a seaplane would have to descend for engine trouble, the airship can still "carry on."

But he had only eluded one danger for a greater. Three returning enemy craft were encountered. The fight waxed fast and furious. F—— dived and banked and turned, now this way, now that. After the fashion of a swarming apiary, other enemy craft engaged, clinging closely to his wake. His observer was wounded in the wrist, numbing his hand, and preventing him from using his machine gun—at least for the time being. Then, with a superhuman effort, F—— climbed above the flock of enemy craft, and, bringing down two in quick succession, made off into the night.

By now the whole countryside had been alarmed. Searchlights and flying shrapnel greeted him at every mile. An "archie" fragment shattered his ankle. Notwithstanding, he still carried on. His machine was riddled with bullets. Owing to the damage, navigation was most difficult and the return journey exceedingly slow.

[*Central News.*

COAST DEFENCE.

A seaplane returning to its lair. The photograph, taken from a machine in the air, shows the curving wake of the seaplane as it bends its course to the jetty.

Consequently he was again attacked, and his gunlayer was once more wounded. But finally this gallant knight of the air drove the enemy off, made his base, and lived to raid another night.

Wonderful as this adventure may seem—and it would be easy to relate scores of similar instances—a yet more wonderful experience befel a British pilot, who, in flying across the lines, well below 4,000 feet, was hit by a shell. Crashing through the body of the machine, the projectile did not explode until it struck the engine. Then two cylinders and the engine bearers flew apart, the splinters fracturing the pilot's leg in two places. Despite the agony, he brought his machine down well within the British lines and then lost consciousness. So badly shattered was the craft that when the pilot was extricated they had to pull him out from the right-hand side through the hole made by the shell.

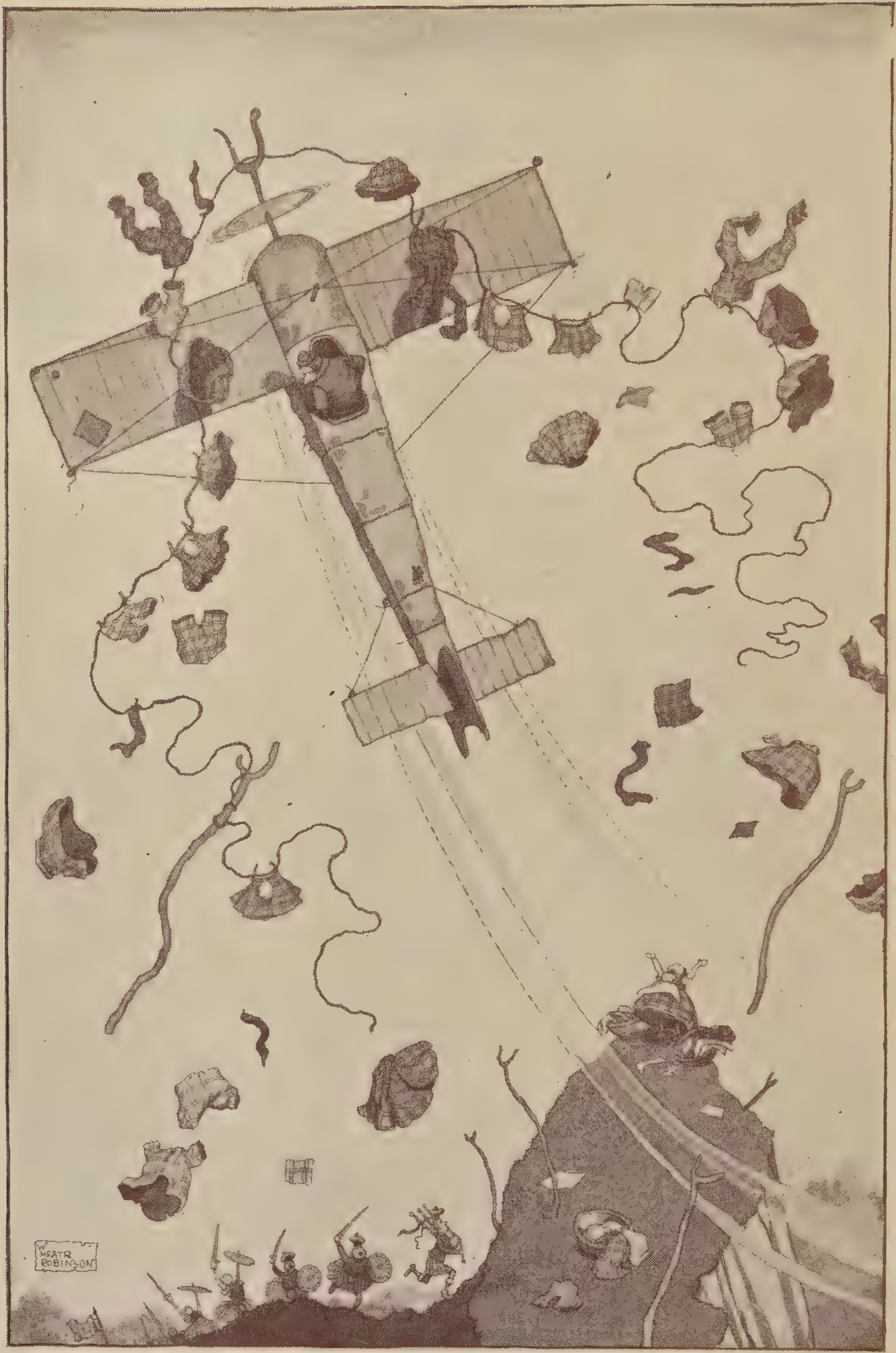
A very notable and successful raid was that achieved by French pilots on Trieste, in reprisal for an enemy aerial bombardment of Venice. The affair will go down in history as one of the most audacious expeditions of the War. Leaving Venice shortly after midnight, the squadron ran into a dense bank of fog. There followed a highly alarming period when the machines lost sight of one another and only missed collision by wing tips. Earth and sky alike were blotted from view, and in such a plight the average airman would have given up the quest as hopeless. But not so these gallant pilots. By a miracle of good airmanship, they kept true to their course, and came out of the fog some two or three miles from their objective.

Flying at an altitude of 4,000 feet, they reached the city. The sky was a blaze of light. Searchlights, great and small, swept from all corners and flashed across the sky, blinding their eyes. The bursting shrapnel was thick as hail, but this did not deter them. In well-ordered precision the machines swooped down, in ever-widening circles, to 2,000 feet, and began the bombardment.

Immediately tiny pin-pricks of flame leapt up from all quarters of the city. The shelling from the ground grew more intense, but still faster dropped the bombs. As they made off across the Bay, the gallant Frenchmen could see, in the brilliant glare of the searchlights, smoke shrouds all over the city. Not content with this, they then singled out the most aggressive of the searchlights and the guns, and, sliding down the beams, reduced both to battered heaps. Then they made for home without incurring a single casualty.

Such are a few examples of the adventures that befell our airmen in Wartime in that new dominion above the clouds. Of the many thousands who lost their lives in the gay hazard it may be said that they "found glory because glory lay only in the straight path of duty."

EDGAR MIDDLETON.



MORE CRIME IN THE AIR.

A reckless young pilot pilfering Scotch garments from the slopes of Ben Nevis.

[*Underwood and Underwood.*

A BELGIAN AERIAL PHOTOGRAPHER AND HIS PILOT WITH THEIR QUAINTLY DECORATED MACHINE.

The Airman's Instruments

IF you were to peep inside an aeroplane you would find the pilot's seat confronted by an array of instruments, most of which have a small dial affixed to them. One does not include among these the "joystick," or rudder bar, with which he controls his machine, as that counts as part of the machine itself. To be able to navigate the air in safety the pilot must be kept informed how his engine is running, what speed is being made, the height to which he has climbed, and a number of other things. And war possibilities and risks made it doubly essential that his knowledge should be accurate. Mere guesswork will not do. So his machine is equipped with many special appliances and you will readily understand that a great deal more goes to piloting an aeroplane than just starting up the engine and handling the controls.

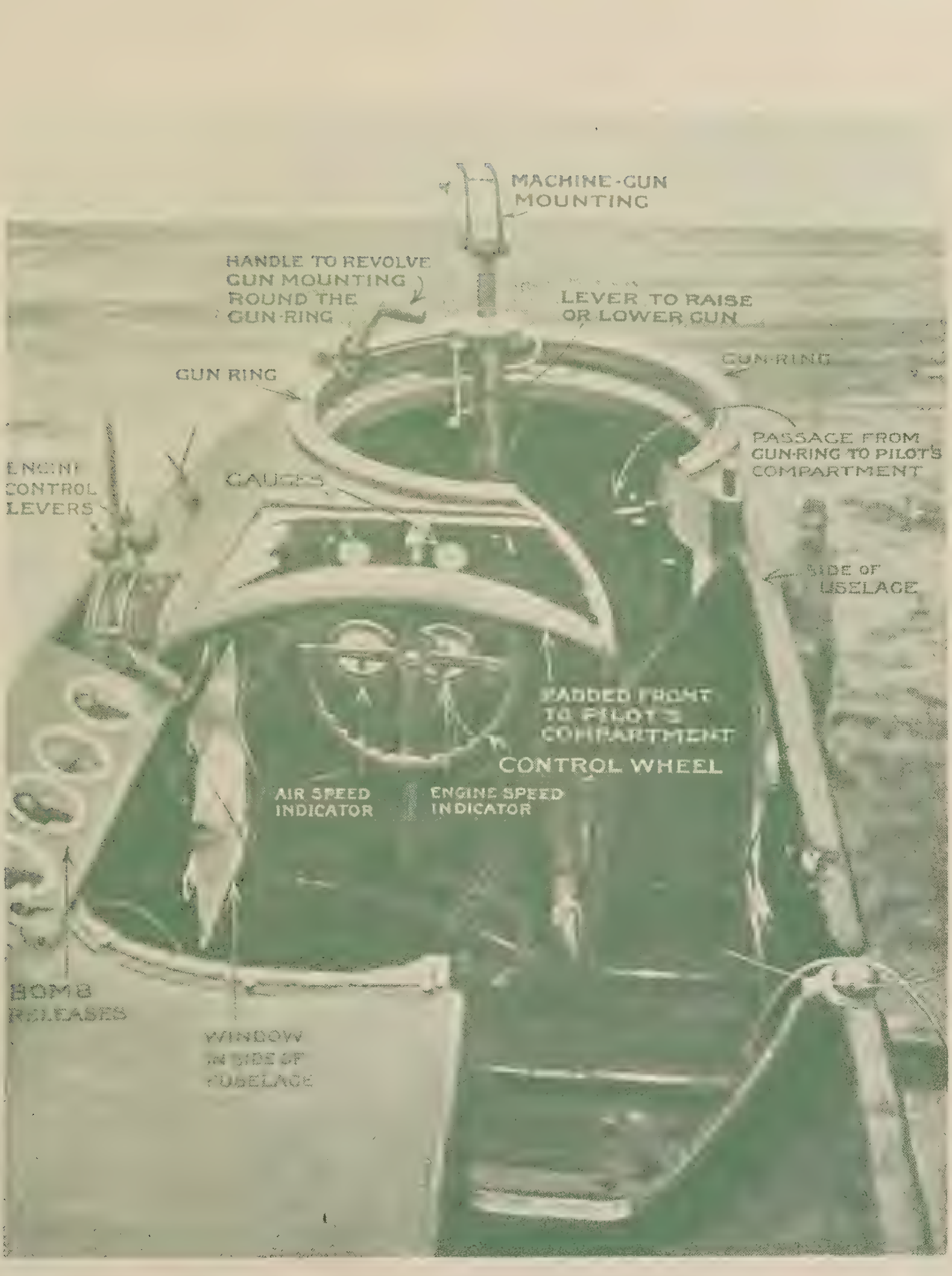
One of the most important of these "navigating instruments," as they may be called, is the revolution indicator, which records the number of times per minute the propeller is going round. An aerial engine may be designed for anything up to a couple of thousand revolutions per minute, and the reading of its speed must be approximately correct if trouble is to be avoided. Owing to the amount of vibration in aeroplanes, and the necessity for the instruments to be as light as possible, absolute accuracy is hard to attain. But makers have to approach this so nearly that there shall be no serious difference between actual performance and the readings shown on the dials. By looking at a motor-car speed indicator you may get an idea of what the air-speed indicator, or "pitot," fitted to flying machines is like. This tells the aviator how fast he is going through the air. A machine flying against a sixty miles per hour wind and showing an air speed of sixty miles would really be stationary over the ground, and it is even possible for a machine to go backward in relation to ground speed.

For showing height an aneroid barometer, or "altimeter," is carried. By consulting this a pilot can find to what height he has climbed. It advises him also of any variations in altitude which his machine may make and which otherwise might pass unnoticed. He is likewise provided with a "bubble," or spirit-level, made in the form of an arch, which guides him in "banking," or turning at the correct angle. If he is at the right angle the "bubble" remains stationary in the centre. Though different in shape, this "bubble" works on the same principle as the familiar spirit-level, and is merely a little bubble of air in some spirit, which moves to and fro as the angle of the machine varies.

Other instruments are the gauges which register the level and the pressure of petrol in the tanks, the latter being usually placed under the pilot's seat. If the right pressure for lubrication, or oiling, is not maintained the engine will get overheated and finally "seize up." Then, of course, down comes the machine. The airman must have a steady eye on all these gauges if he would avoid running suddenly into disaster.

For shaping his course the pilot is supplied with a compass. In their main principles air and sea compasses are somewhat alike. Both have to be "swung" for the rectification of errors when first installed. But the air compass must be "corrected" differently from the ship's compass, and the utmost care taken in avoiding errors due to the magnetic attraction of articles placed near it in the fuselage. Very

THE EYES OF THE FLEET:
A SHORT SEAPLANE.


MACHINE-GUN MOUNTING
HANDLE TO REVOLVE GUN MOUNTING ROUND THE GUN-RING
LEVER TO RAISE OR LOWER GUN
GUN-RING
GUN RING
PASSAGE FROM GUN-RING TO PILOT'S COMPARTMENT
ENGINE CONTROL LEVERS
GAUGES
SIDE OF FUSELAGE
PADDED FRONT TO PILOT'S COMPARTMENT
CONTROL WHEEL
AIR SPEED INDICATOR
ENGINE SPEED INDICATOR
BOMB RELEASES
WINDOW IN SIDE OF FUSELAGE

THE NAVIGATING AND FIGHTING QUARTERS OF A GOTHA.

This drawing, made from a captured machine, shows the pilot's compartment and his control wheel and indicators, and a gangway which allowed the observer, who operated the revolving machine gun in front, to pass backward and forward.

small magnets are employed in correcting air compasses for local errors.

So far we have considered navigating instruments only. Another set, quite as important in their special functions, are those installed for fighting purposes. Among these is the galvanometer, which helps in aiming the gun mounted forward. There are also the bomb releases and the "sights" for aiming bombs, as described in the article on "Aircraft Weapons in War."

Aeroplanes are also fitted with partly automatic cameras for taking photographs of objects on the ground beneath them. Usually the plate is exposed by the pilot, who either pulls a string or presses a trigger for the purpose. But automatic cinematograph cameras have been fitted on both airships and aeroplanes.

An airman must, of course, be able to consult his instruments by night as well as by day and to read his map, which is stretched before him on a specially designed holder. For this purpose a system of electric lighting within the fuselage has been devised. Small lights glow on the dials, just sufficient to make visible what is recorded there, but not strong enough to affect the pilot's eyes.

The higher one ascends the rarer grows the air and the more difficult it is to breathe. It is now quite common for flights to be made at an altitude of from fifteen to twenty thousand feet, and to enable airmen to remain at such heights in comfort and safety oxygen supplies and small electric heaters are issued to them. The heaters can be buttoned inside the tunic if so desired. Without these aids there would be grave danger of an airman being placed out of action by the cold and the difficulty of breathing.

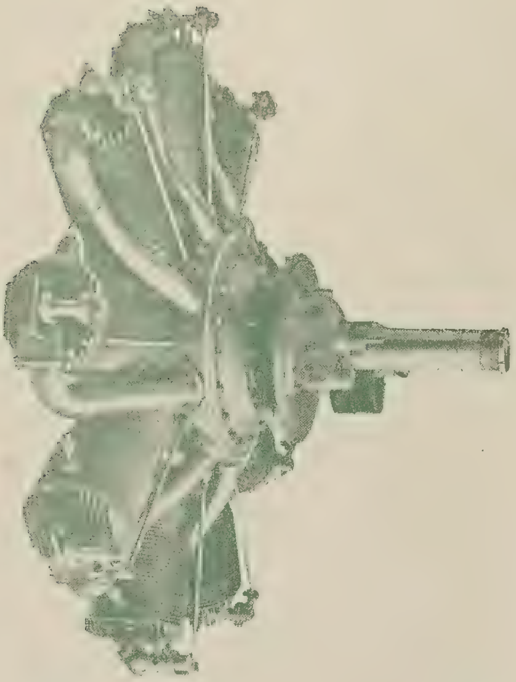
Nearly all aeroplanes are to-day fitted with compact and efficient wireless telegraphy (known as "W.T.") sets, capable of sending and receiving messages up to about 20 to 30 miles. It is also possible, by an ingenious device, to telephone from the machines. Consequently the aeroplane has become the "eyes" of the General or Admiral, and in reasonably clear weather, can generally contrive to give him reliable information as to the disposition and movements of an enemy. In the old days it was the duty of cavalry, in the case of the Army, and of light cruisers and destroyers, in the case of the Navy, to act as scouts to their respective commands, but such was the advance in flying and flying appliances during the War that latterly the aeroplane and the seaplane did nearly all this work.

An aeroplane has small space or means to spread an ordinary aerial wire, so a wire is fitted on to a drum inside the body of the machine. To this wire is fitted a lead plummet. When the airman is not using his W.T. this wire is wound up on the drum, but as soon as he wishes to send or to receive a message, he lowers the lead plummet until there is sufficient aerial wire out for his needs. By raising or lowering the plummet he can lessen or increase the capacity of his aerial, and consequently, to a large extent, control the strength of his messages. As he flies, the aerial, instead of hanging vertically, takes up an angle against the line of flight, or towards the tail. This makes very little difference so long as the wire does not touch any metal part of the machine, but if this should happen the W.T. would "earth," or short circuit, and the operator would quickly know it.

Not only is W.T. in an aeroplane of great importance in sending messages in connexion with enemy movements, but it has frequently been the means of saving an airman's life. Suppose a seaplane has gone on reconnaissance over the sea, perhaps many miles from land. Something goes wrong with the engine and the airman is forced to come down. Before doing so, he can send a W.T. message and it will probably be immediately picked up ashore, and help sent with the least possible delay. So keen are seafaring people to help the flying-man in distress that on more than one occasion no fewer than seventy vessels went out to hunt for an overdue seaplane.

WAITING FOR THE "FERRY."
A row of Whitehead Fighting Scouts ready to be flown across Channel.

Moreover, an aeroplane flying over desert country, such as parts of Egypt, may come to grief, and but for a W.T. message no one would know what had happened, or where, and the airman might be captured by the enemy or, worse still, die of thirst in the waterless wilds.



Photo] [F. N. Birkett.

110 HORSE-POWER ROTARY AIR-COOLED LE RHONE ENGINE.

It is a curious fact that wireless is less efficient by day than at night, and especially in strong sunlight. Nobody quite knows why this should be so, though scientists have given the matter careful consideration. The truth is that "wireless" is almost as much an "infant" as flight itself.

Aeroplanes are not equipped uniformly. The appliances fitted in them are always determined by the type of machine and the work it is intended to do. As explained elsewhere, war machines vary considerably in type and just as widely in their work. Some are bombers, some scouts; some are designed for one sort of use, some for another. But clever brains are always engaged in trying to better the design of the machines themselves, and to improve their equipment, especially that part of it which makes for greater fighting efficiency.

AN ARMSTRONG-WHITWORTH TWO-SEATER.

"THE GREAT SEAPLANE, MEASURING FIFTY FEET FROM TIP TO TIP, WAS SWUNG OUT BY THE DERRICK AND DROPPED INTO THE SEA."

It

THE heat was intense, and on board H.M.S. *Crossbow* a clammy moisture was each man's portion. It was in the early days of the War, and the aircraft allotted to the British Navy at this particular outpost of Empire consisted of a large, unwieldy seaplane and one single-seater scout biplane, which latter dwelt on shore with a party of marines.

This very morning the scout had sailed away into the grey dawn on her first reconnaissance, and all day telescopes on the *Crossbow* had been turned upward to the beating blue sky, until eager guessing had given way slowly to headshakings and gloomy forebodings, varied now and then by one or two cheery optimists.

"She'll be back before dark. She's come down somewhere for repairs."

"She won't. She's done for. It's fate. Even an aeroplane can't keep going in this accursèd climate." The speaker mopped his face liberally.

"Constant wishes to be allowed to search for Breton," remarked Kenmore, the Gunnery Lieutenant, joining the group on deck and raising his binoculars to search the brazen heavens.

"They were school chums," said the Paymaster. "Wonder if it would be any good? Where are we if his 'bus follows her mate and neither returns?"

"The skipper must decide, I suppose," said a junior lieutenant. "But Constant's mount will offer a far bigger target if there's any shooting going on."

"Besides," argued the Paymaster, "unless Breton has fallen into the river—in which case he is presumably drowned—he is out of reach of assistance from that lumbering old thing."

He pointed to the seaplane lying across the broad low deck of its mother-ship.

"It's woods, woods, woods—eternal woods," said Kenmore, "and if Breton has come down on a tree-top——"

"'Rock-a-bye, baby, on the tree-top,'" sang the Surgeon softly.

"Quite so, Tyndall," Kenmore agreed. "And you know the rest of that apt little ditty— 'Down will come Breton, biplane and all!' The boy ought to have been back eight hours ago," he added uneasily. "The Germans are somewhere up river and may have guns and—— Well, Constant?"

"I am going after Breton," said Constant, crossing the deck with eager step. "At dawn, to-morrow."

They surveyed him coolly. "Good business!" said one, and the rest grunted approval.

"Don't you go and lose the last 'bus," said Kenmore, threateningly. "We could spare you at a pinch, but not your mount!"

Constant laughed, but the smile quickly faded as he in turn snatched a telescope and swept it round the empty sky over the dark mass of distant forest.

All night the stars burned and blazed till, very swiftly and almost imperceptibly, they melted away in the glimmer of dawn. On the instant the great seaplane, measuring fifty feet from tip to tip, was swung out by the derrick and dropped into the sea. Ten minutes later it was skimming the smooth water and gathering strength for flight.

"She's off! She's away! She's a daisy!" exclaimed the watchers as the seaplane leaped into the air and mounted steadily

"THE MACHINE LEAPED INTO THE AIR AND MOUNTED STEADILY."

till it topped the forest by a thousand feet. Just then the sun came up out of the ocean, transforming the monster mechanism into a silver bird before their eyes, and half-blinding the pilot as he turned for a last look at the ship.

Constant travelled alone, for the seaplane had only two seats, and he intended to bring Breton back, alive or dead, in the now empty chair. Flying at a high speed, he had in about an hour's time a clear view of the broad low hill that Breton had gone to examine. At once he rose to a high altitude, for he was suspicious of hidden guns, and rumour had it that the enemy were encamped in the neighbourhood. Presumably Breton had met his fate here or hereabouts, and Constant circled the hill with eyes alert behind the dark goggles.

He glanced at the neat Lewis gun in front of his machine, and smiled grimly. But the smile vanished abruptly and he leaned forward and stared hard at his treasure, startled by a sudden trick of memory. Had he—or had he not—remembered to slip on the belt of cartridges? He knew without further investigation that he had not. In his anxiety to get away he had made a blunder that might well prove serious. He half rose from his seat, peered forward, and sat down again with an exclamation of dismay and annoyance. The gun was a mere ornament. But there was no remedy, so he turned his eyes earthwards again and presently descried a small camp and a few running figures. He circled over this spot for a considerable time. He had a strong inclination to drop one of his four bombs on the place, but as he could see no guns he decided to go farther afield before parting with his precious explosives. He flew on westward for some minutes, and then, catching sight of an expanse of water, swerved southward to inspect it. He found a flat swampy region where the swift narrow river, hidden above and below by thick forest, spread itself out for a couple of miles in a broad, shallow lake.

Something gleaming near the farther shore attracted his eye and drew him with the force of a magnet. He was half-afraid to look more closely at the bright narrow shaft, for it bore a striking resemblance to the wing of an aeroplane standing almost erect out of the water. He dropped to within two thousand feet and could then plainly discern the red, white and blue circle on the wing of Breton's biplane.

Down he flew, sick with apprehension. A nearer view showed a man huddled up on the struts, the rigid rods that connect the upper and lower planes. He was well above water, but something was evidently far wrong, for he neither waved nor made any sign of life.

Reeds and low bushes were dotted in profusion over the lake, constituting a grave danger to a seaplane, whose pilot likes a clear surface. But Constant had to alight somehow and somewhere and he chose the middle of the lake. Then, with great care, he motored along the surface, threading his way cautiously until he came within hail of Breton.

"Paul!" he shouted twice, but the twisted figure made no response. Constant motored up as closely as he dared, leaving barely room for his long wings to sweep round.

Suddenly, to his astonishment, Breton's voice rang out sharply, "A rope, Jim! Quick!"

Climbing out of the cockpit, Constant walked warily along the fuselage towards the tail. Once clear of the upper plane, he flung a coil of thin rope across the water, retaining the end in his left hand. It fell short. He hauled it back, coiled it once more, and again flung it deftly.

"What's wrong?" he shouted, for though the rope fell close to Breton he made no effort to catch it.

"Again—oh, quick!" cried Breton.

Constant swiftly drew in the wet rope and again let fly. "Catch!" he cried.

This time Breton splashed down in a heap, seized the rope and almost shrieked the one word "Pull!" At the same instant the wing he had leaped from sidled gently down and sank just under water.

"Quicker! Pull faster!" yelled Breton.

A shot rang out from the northern bank with startling suddenness.

"Hullo!" exclaimed Constant, and looked round, inwardly cursing afresh his gross stupidity in leaving the ammunition behind. Here was a glorious opportunity for the Lewis gun! But regrets availed him nothing, and an urgent cry from Breton recalled him to the task of hauling in his dead weight. For Breton seemed unable to help himself further than by clinging to the rope with one hand.

One bullet after another spat into the water at varying distances from the seaplane.

"Native—and a bad shot at that!" Constant called over to

Breton to hearten him, as his nerve seemed fast going. "It's like landing a pike to get you along!" he added, laughing.

"Quick—quick! IT's close behind!" gasped Breton, beginning to kick feebly.

"What is?" asked Constant.

There was no reply, and an appalling fear seized and gripped the rescuer. In this muddy, tropical lake IT might be any sort of uncouth monster. At any moment Breton might be seized and drawn under water before his very eyes. His flesh crept, and a cold sweat broke over him. Hand over hand, he hauled in the rope, shouting words of encouragement.

"Hold on! IT's not there! You're almost in!"

A ripple broke the still water beside the wreck.

"Kick hard! Splash! I've got you!" shouted Constant, sick and trembling. He ran towards the cockpit, wound his leg round the nearest strut for leverage and pulled with all his strength. Breton's face was grey and he was fast approaching a state of collapse.

"Hold on and I shall haul you right up here!" exclaimed Constant when he had drawn the almost lifeless form close to the seaplane.

"I can't!" gasped Breton.

"Stand, then, and climb up—it's shallow enough," Constant urged, but Breton's strength had gone. He lay inert, fainting.

There was not a moment to lose, and Constant did not hesitate. He sprang into the water, and with a new strength born of fear raised Breton and flung him over his shoulder with the fireman's lift. Blindly, madly, he scrambled up, panting, and dropped his unconscious burden into the observer's seat.

A bullet whizzed past and he supposed others had done the same during the last few awful minutes. But a bullet meant a clean death, a straight, clean death—whereas THAT! He looked shudderingly down at the muddy water. Something not unlike a rough tree-trunk rose slowly, with the rope Breton had dropped lying across its back. Its long, scaly snout poking up into the air was not good to look upon.

Constant hung over Breton, but a tap close to the tail of the seaplane from a well-directed shot reminded him that it was his first business to protect his craft, and he sprang into his seat and started the engine. He motored slowly at first among the bushes, but soon flung caution to the winds and drove ahead over the tops of bending

CHARLES J. DE LACY. 1917.

"BRETON WAS WELL ABOVE WATER, BUT SOMETHING WAS EVIDENTLY WRONG, FOR HE NEITHER WAVED NOR MADE ANY SIGN OF LIFE" reeds, catching masses of floating green stuff and plucking long grasses from their muddy bed.

The single inexpert rifleman had now received reinforcement, and a volley rang out which startled Constant. For the leaden messengers now came sweeping along with marked accuracy. Two hits were made, not vital. Would she never rise? The lake was not long, and Constant had a vision of motoring round and round it for ever, after the manner of the Flying Dutchman, followed always by the bullets of the enemy. The water was becoming shallower, more muddy, stickier—ah, suddenly she leaped! There was a glorious lifting sensation—freedom—relief—as the floats left the water, trailing a cloud of green vegetation behind.

Up, up they sped. Breton moaned and raised his head a little, trying to speak. Constant managed to snatch a flask the surgeon had given him, held it between his knees and opened it with one hand.

"Drink that," he commanded.

By this time they were out of reach of rifle bullets. Breton tried again to speak and succeeded in framing a few words. Constant could hear nothing for the whirr of the engine, but he read on his lips a single word and his glance explained the rest.

"Oh, your 'bus?" he shouted in reply. "Why, certainly. It would be a pity to let them get any of the parts."

He wheeled round with a majestic sweep and returned to the lake, preparing to release a bomb as they drove straight for the wrecked aeroplane.

"Look!" he exclaimed, jerking his head towards the northern bank. Breton slowly turned his dazed face and saw a huge dug-out canoe, paddled by a number of natives, swing out from the shelter of the woods and advance with marvellous rapidity. At the farther end of the canoe several men in light suits were crowded together.

"We shall give them summat to think about presently," chuckled Constant and released a bomb.

A tremendous waterspout resulted, but when the lake subsided into placidity the wreck was still visible and apparently untouched. The canoe, however, was heading for the bank in panic.

Constant was greatly annoyed with his failure, but there was no time to rectify it if he meant to catch the enemy, so he decided on an instant offensive upon the canoe.

Breton's lips moved. "Is IT gone?"

Constant shook his head in disgust.

"No—but IT?" repeated Breton.

Constant only nodded sharply towards the canoe. It was nearing the bank, but at sight of the approaching demon in the skies the natives flung themselves headlong into the lake and scattered for shelter.

The half-dozen Germans, thus deserted, raised rifles and fired. The left wing was hit, but Constant, undaunted, swooped down and dropped two bombs almost simultaneously. When he looked back there was no canoe—nothing. The seething waters settled down again and all was still.

"That's settled *their* little account!" he shouted to Breton, and swung back to the wreck. With no fear of disturbance from rifle fire, he now took plenty of time, flew low, and dropped his last bomb in the very centre of the sunken British biplane.

Looking up with a flush of triumph on his cheeks he saw to his horror that Breton had slipped on his seat and was only half conscious. The dangers of the lake had to be faced yet again, and Constant dropped once more into the clearest part, splashed along for two hundred yards, and shut off the engine.

"Now, my boy," he exclaimed, raising Breton's head and applying the brandy flask to his lips, "this won't do."

In a short time Breton breathed more naturally. Then Constant broke a biscuit into small pieces and handed him one bit after another, urging him to eat.

"Your right thumb is broken, I see," he announced after a pause for observation, "and you have lost your front teeth, poor beggar!"

"I've lost the 'bus, which is all that matters," said Breton, curtly refusing Constant's offer of first aid. "Leave me to Tyndall," he said.

"How did it happen?" asked Constant, burning with curiosity.

"They fired at me from a camp on the hill," said Breton slowly. "They were fixing up a big gun and a little one spat at me."

"Well?" asked Constant.

"I had only two bombs," said Breton feebly, "but I dropped very low to make dead sure. The small one must have potted my tank, I suppose, but it was such a chance, you know, before the big one was fixed. I had to take the risk." He spoke apologetically. "I gave them both bombs and made a lucky hit."

"Good man!" cried Constant. "I saw no gun there this morning."

"No—you wouldn't—unless they had others behind."

Breton paused for a time and reflectively munched a bit of biscuit with his back teeth. "I suddenly noticed my gauge," he continued in a dull tone; "the petrol was fast petering out and I knew I was done for. I made for the river, for I thought if I landed there I could make a dash for the coast by following it down, but you saw what happened. It was lucky for me that a bush or a snag or something broke the wing off."

"Why didn't you try to go ashore?" asked Constant.

Breton replied with a look.

"Was IT there all the time?" asked Constant abruptly.

Breton nodded. "I fell into ITS ghastly, slimy lair, I suppose," he said, shuddering. "I waved to some natives, but they ran for their lives, and never came back. I saw IT almost at once and climbed up to the struts and hung on. I knew my thumb was broken, but I don't think I realized my teeth had snapped till you told me. I suppose I'm lisping?"

"Never mind. What did IT do?"

"Nothing. Just lay and waited. And all night long the wing slipped ever so slowly and steadily. I dared not breathe. Then I heard your hum and—that's all!" Breton stopped abruptly.

"Enough too!" said Constant warmly. "You've had a fair twenty-four hours of it. But you'll get a new 'bus when the skipper hears what you've done—to say nothing of the thanks of both Houses of Parliament!"

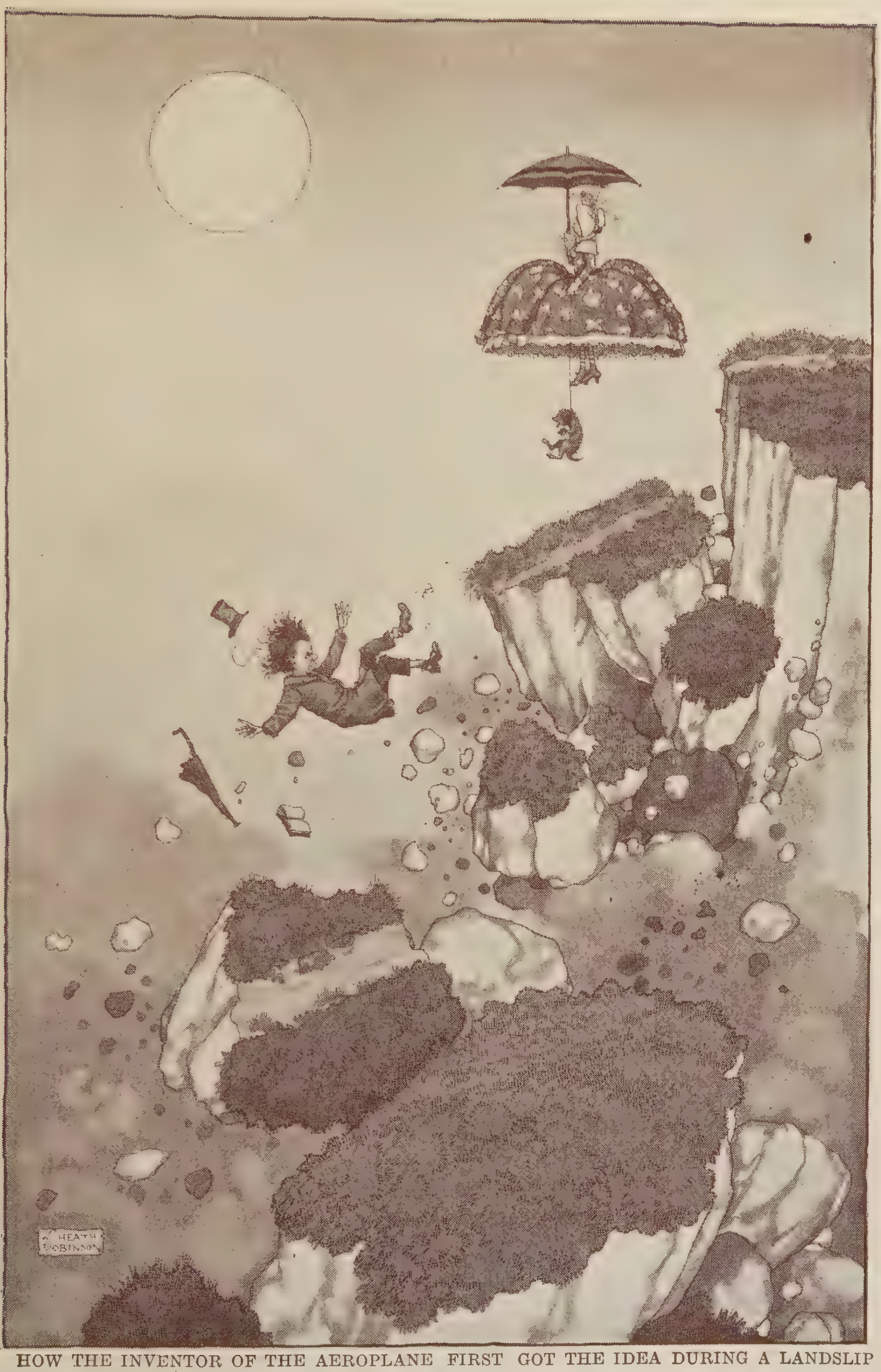
Breton smiled faintly. "If you hadn't come——" he began.

Constant interrupted quickly. "Oh, that's all right!" he said and sprang to his seat. "You're fit to go on now. Lie back comfy, Paul, and I shall have you back to the ship in time for breakfast."

A rush through the water and up into the air, and they were off on the return journey. After forty minutes of steady flying Constant waved his hand and pointed ahead. Breton leaned eagerly forward to gaze at a shimmering line on the horizon that grew every moment broader and bluer.

"Now for a graceful landing!" said Constant to himself. He glided down, dashed into the water, and drew up within fifty yards of the *Crossbow* amidst ringing cheers.

M. G. JOHNSTONE.



HOW THE INVENTOR OF THE AEROPLANE FIRST GOT THE IDEA DURING A LANDSLIP IN THE PYRENEES.

[L. N. A.

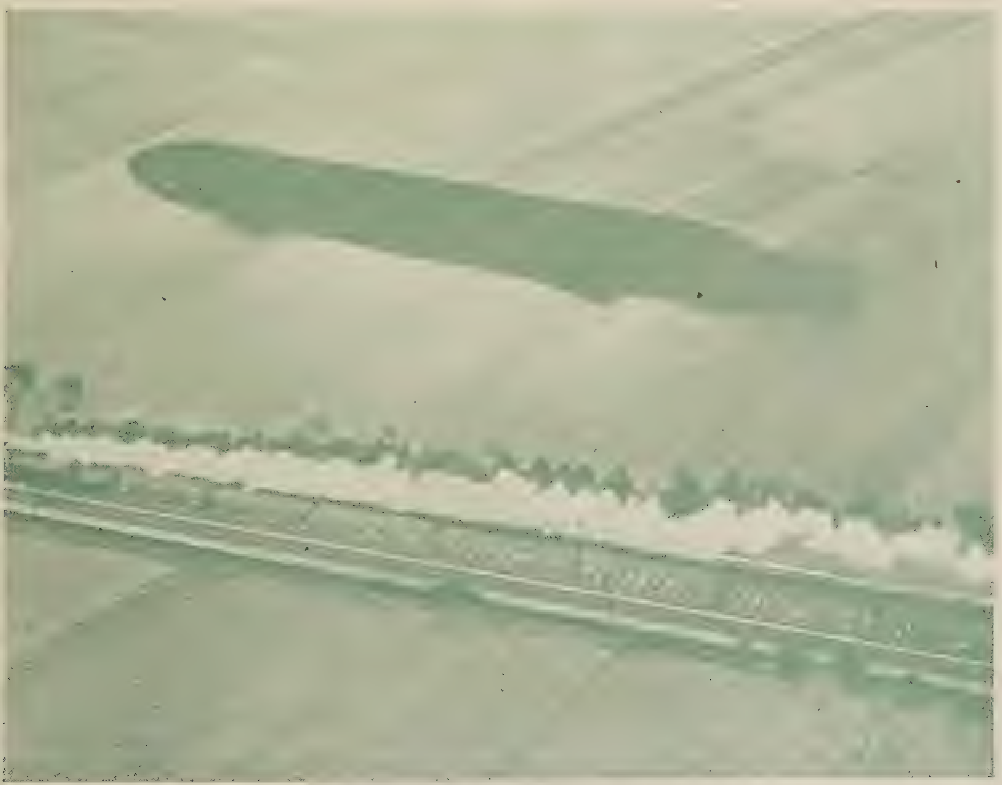
AN AIRSHIP OVER ST. PAUL'S CATHEDRAL.

The spire in the foreground is that of St. Bride's Church, in the shadow of which the "Wonder Book of Aircraft" has been produced.

The Future of Flying:

The Uses of Aircraft in Peace-Time

IF you consider any of the great scientific discoveries of recent years, and consider, too, how they have developed, you will soon come to the conclusion that prophecies made in early days have generally been very different from the actual happenings. Thus when the first railway was opened it was generally believed that the new means of travel would be very useful for comparatively short distances, but that as a general rule railways would be devoted to the carriage of goods from place to place. If you had told a man in the year 1840, say, that sixty years later he would be able to travel



[E. N. A.

A ZEPPELIN RACING AN EXPRESS.

This photograph was taken from the Zeppelin itself, and shows the shadow cast by the gigantic dirigible.

from one end of Europe to the other at an average rate of forty miles an hour he would have laughed.

Similarly, when the great discovery of X-rays was made, it was recognized that a wonderful step forward in scientific research had been accomplished, but hardly anyone foresaw how great a help to surgery X-rays would prove. The application of electricity, again, developed on quite unexpected lines. No matter what discovery or invention is considered, it will be seen that development in nearly every case has been on very different lines from those at first anticipated.

When we come to consider the conquest of the air, it is necessary to bear in mind at the outset that it is only a very few years since the first successful flight was made. This is not only the newest of man's conquests and achievements; it has also been the swiftest, for no other branch of discovery or invention has ever been exploited to the same extent in so short a time. But the conquest is yet incomplete; much remains not only to be done but to be discovered before the aeroplane and the airship reach their final forms. Thus any forecast of what aircraft will accomplish now that Peace has come is bound to be partial; it is only possible to indicate vaguely the lines along which development will probably proceed.

There is, however, a definite mathematical law which assigns certain functions to airships and others to aeroplanes. The airship, mainly through the experiences of the Zeppelins, has been proved a failure in land war; aeroplanes can outfly it, and can attack it in ways that admit of little effective defence. In consequence the aeroplane was almost solely used in the later stages of the War, and the "gasbag" was discredited. But under peace conditions attack and defence are not pressing problems, as they were in war; the only problem is that of the greatest utility, and here, for weight-carrying purposes, mathematics step in and say that the airship has its place.

The matter may be stated quite simply. In building an aeroplane every square foot of wing surface means just so much weight and so much carrying power. If you double the wing surface, you must increase the size of the engines for lift; you must double the strength of the wing bracings, or more than double it, to take the added strain; and roughly it may be said that double lifting power means double weight. Thus, suppose a small aeroplane weighs five hundredweight, and carries a useful load of two hundredweight: then a machine that will carry a useful load of four hundredweight will weigh half a ton, and the bigger the aeroplane the greater is the difficulty of successful construction, the more are the problems of wing strain and the like to be overcome.

Now when it comes to building an airship of the gasbag type, if you double the size and weight of the gasbag you increase its gas-holding capacity not merely to double as much, but to four times as much, so that the bigger it is the more efficient it will be. Thus, if a balloon of thirty feet in diameter had a lifting capacity of two hundredweight, a balloon of double the size would have a lifting capacity not of four hundredweight but of *eight* hundredweight, and if the size were doubled again it would lift thirty-two hundredweight.

[Illustrations Bureau.

A PASSENGER-CARRYING ZEPPELIN.

Count Zeppelin and Army leaders in the car of a pre-war Zeppelin.

This fixed mathematical law makes the airship the ideal weight-carrying air liner under peace conditions. And the gasbag has other advantages. Fitted with wireless, it can, in case of engine trouble, simply drift in the air and send wireless calls for assistance, just as a liner does at sea, so that other airships can come to its assistance and tow it to safety. The aeroplane, on the other hand, in case of engine trouble is forced to descend, no matter what the dangers of descent may be, and possibly the descent itself will mean loss of life.

On the other side it must be said that the airship can never hope to rival the aeroplane in the matter of speed. This fact, as far as can be seen at present, will give a definite place in peace-time to each form of craft. The airship will become a weight-carrying vessel, with a rate of travel of about sixty miles an hour, while the aeroplane will be a swift vehicle for the carriage of mails, small numbers of passengers, and commodities that require the quickest method of transportation. Problems of air pressure and engine-power have been so far settled that the speed of the airship can be regarded as more or less fixed, so far as the carriage of useful loads is concerned. But the ultimate speed of the aeroplane has yet to be determined; at the beginning of the War it was thought that something like a hundred and twenty miles an hour would be the highest limit; after four years of War there were in existence numbers of scouts capable of flying nearly two hundred miles an hour, and nobody would dare to prophesy even that speed as a limit, for construction and design are still advancing.

In quite a number of places the experiment of carrying mails by air has already been tried, and such success has attended these experiments that it is certain that many definite air routes for mail-carrying will be established in the near future. There are in existence maps showing the routes planned for mail and passenger-carrying aeroplanes —and it is not such a simple matter as it may look to establish such routes. It is necessary first to ascertain definitely the prevailing winds in certain areas at certain altitudes, in order to get the best results in flight each way, and to determine the stages of flight, say from Paris to Hong-Kong, so that aeroplanes used in such a service may be of the greatest possible use not only to the two termini but to the intermediate calling stations that will be set up. The establishment of an air route calls for exact knowledge of weather conditions not only on the ground but on the different levels at which aeroplanes will fly; for when it comes to adapting what has been principally developed as a War machine to peace conditions it is necessary to consider the factor of cost as well as that of efficiency.

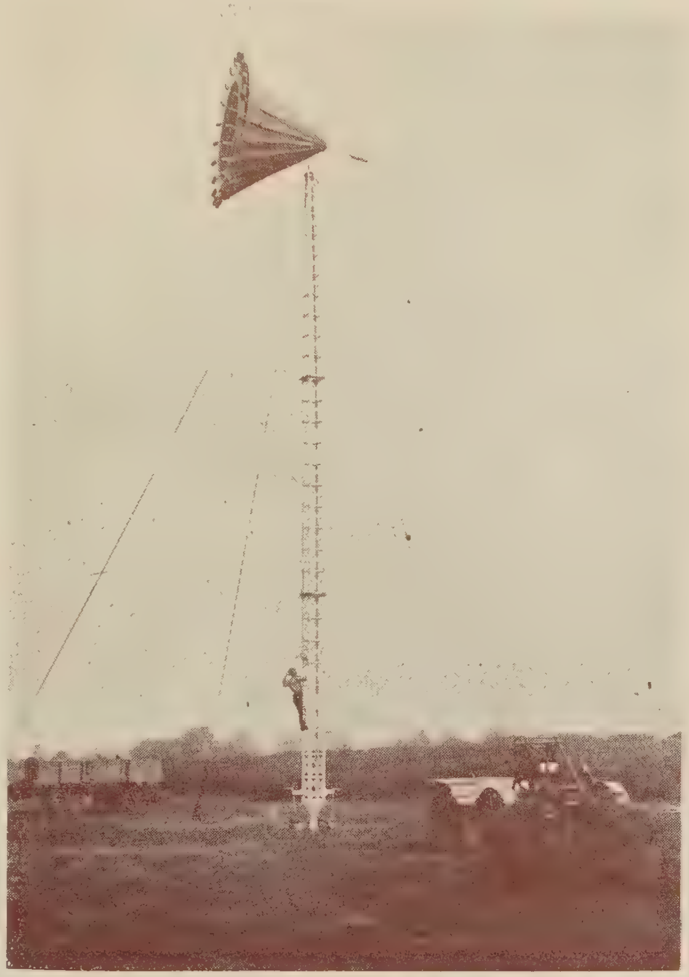
[E. N. A.

A ZEPPELIN CRUISING ABOVE THE "IMPERATOR," ONE OF THE LARGEST VESSELS IN THE WORLD.

War developed the aeroplane so rapidly because efficiency had to be considered independently of cost; peace-time development will be on the lines of making flying not only useful, but economical and safe as well.

Consideration of the differing qualities of aeroplane and airship shows that, in the case of the latter, prevailing winds and climatic conditions will have to be studied even more closely than in connexion with the former. For not only will the engine-power be less in relation to the weight carried than in the case of aeroplanes, but the airship is far more at the mercy of wind and weather than is the aeroplane. It is more than probable that such definite routes as were established at sea in the days of the old "wind-jammers" will come into existence; there will be definite "lanes" of traffic in the air, just as there are at sea, and airships will take advantage of the trade winds on their journeys. There will be fixed outward lanes and equally fixed homeward routes; between them will lie the areas of varying wind currents, which sailors of the air will avoid as sailors of the sea avoid dangerous waters. Already the study of air currents has advanced so far that the existence of different wind currents at different altitudes has been established, and we may take it that the pilot of the future aerial merchant service will be provided with charts that show not only the prevailing winds at the surface of the earth, but also the prevailing winds at, say, a thousand, two thousand, up to twenty thousand feet above sea level. For, in order to make the best use of air currents, it may be necessary to do some part of a voyage at a height of five or six thousand feet, and for another part of the distance to rise or descend to, say, ten thousand feet or four thousand feet. And with wireless telegraphy as an aid even those vast areas of disturbance known as cyclones and anti-cyclones can be utilized to help commercial aircraft on their way. It is one of the side issues of aviation that it has forwarded the study of weather conditions to such an extent that the modern meteorologist, with the help of wireless telegraphy, is often able to tell the man in the air just what air currents lie a hundred or two hundred miles ahead of him.

A few years ago the "air liner" was a mere fancy on the part of the imaginative; to-day there are aeroplanes in existence capable of carrying in comfort and security more than sixty persons apiece. The losses of aeroplanes due to fighting and other war conditions to a large extent obscured the fact that the modern aeroplane is almost as safe a means of transit as the modern passenger ship. It is easy to conjure up a picture of what peace-time air work will be like in the course of a few years, when commercial companies have been formed to make real use of the new means of conveyance.



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AN ANCHORAGE OR MOORING-MAST FOR AIRSHIPS.

The pointed head of the envelope fits into the movable cone, and the airship is then secured by cables, which allow it to swing freely and to ride out even a heavy gale.

Even with the development of to-day, apart from advances that may be made later, it is possible to picture great landing-grounds here and there throughout the world, from which the big 'planes will set out, and at which they will arrive with passengers and mails, thus drawing the nations of the world closer together. Here and there, too, will be the big sheds that house the airships, each of which will count its cargo in tons, and cover the distance between, say, London and New York, in three days. Then there will be other centres where the fast little aeroplanes congregate—three or four-seaters that travel at anything from a hundred and fifty to two hundred miles an hour, and form an express service for the conveyance of those who want the highest possible speed, or for express mail services. One may picture definite routes and heights in the air reserved for each class of vessel, so that certain areas will be dotted with aeroplanes and airships while, outside the fixed routes, will be great tracts of air as deserted and unexplored as the Sargasso Sea, since science has shown them to be unprofitable areas for travel.

In considering the commercial possibilities of air traffic it must be borne in mind that the airman has always two degrees of speed to consider, the air speed and the earth speed. If a machine capable of travelling a hundred miles an hour gets into a head wind that is blowing at thirty miles an hour, the result is that the machine is travelling a hundred miles an hour in a forward direction, and at the same time being blown backward at the rate of thirty miles an hour—the net speed, in relation to the earth, is seventy miles an hour, although the air speed is a hundred. If the same machine gets into a following wind which blows at thirty miles an hour, then its speed in relation to the earth will be a hundred and thirty miles an hour. That is why the weather conditions must be studied so carefully in planning routes, so that air currents may be made to help the engine, not to hinder it, for the addition of that thirty miles an hour to what is known as the earth-speed (the speed in relation to the earth) will mean a great saving in time and fuel, and consequently in expense.

The War developed the aeroplane and the airship at a swifter rate than any other invention or discovery has ever been developed; the uses of peace will accomplish still further development, but on rather different lines. Speedy climbing powers, ease in handling, range of view, and greatest possible air speed—all these will still be considered; but they will be considered more in relation to weight-carrying ability, the cost of running and upkeep, "useful load," and the durability of the machine, than was possible during hostilities.

It is more than probable that the commercial air fleet of every nation will be partially under Government control, and Government subsidies will be provided in order that certain portions of the fleet may be so built that they can be adapted to war uses at instant notice, just as in the case of the merchant service, out of which many liners were taken and armed for war service as soon as hostilities began. But this will not lessen the peace uses of the aeroplane and the airship; rather, by keeping these vessels thoroughly up-to-date and in perfect condition, it will assist commercial development and ensure efficiency in the air services of the world.

E. Charles Vivian.

[*British Official.*

A MILITARY SILHOUETTE.

This artistic photograph shows a British anti-aircraft gun in action on the Western Front.

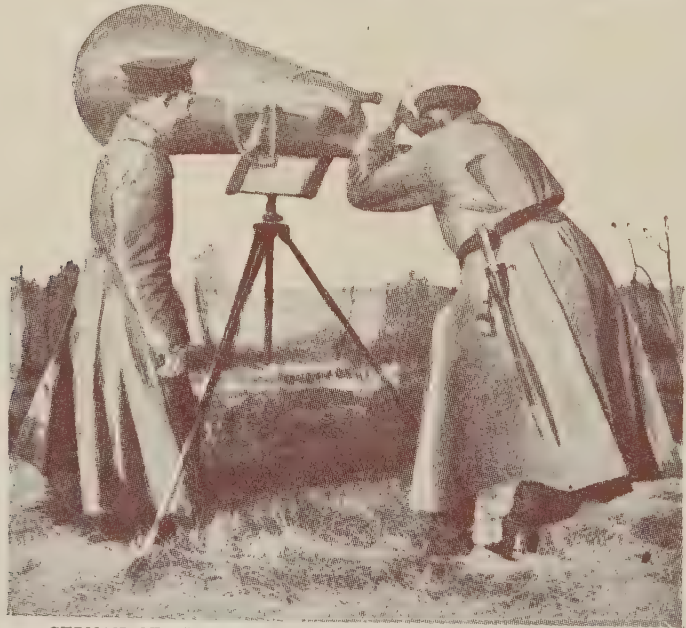
Anti-Aircraft Devices

BEFORE the War broke out, means to combat hostile aircraft had not been very thoroughly considered. Every nation had issued laws denying the right of foreign craft to fly over any other country how and when it pleased. Local authorities had taken similar measures to prevent aircraft flying over thickly populated districts, but nobody had thought out clearly by what means these laws and by-laws were to be enforced. You cannot take an aeroplane's number as easily and simply as that of a defaulting taxi-cab or motor-car.

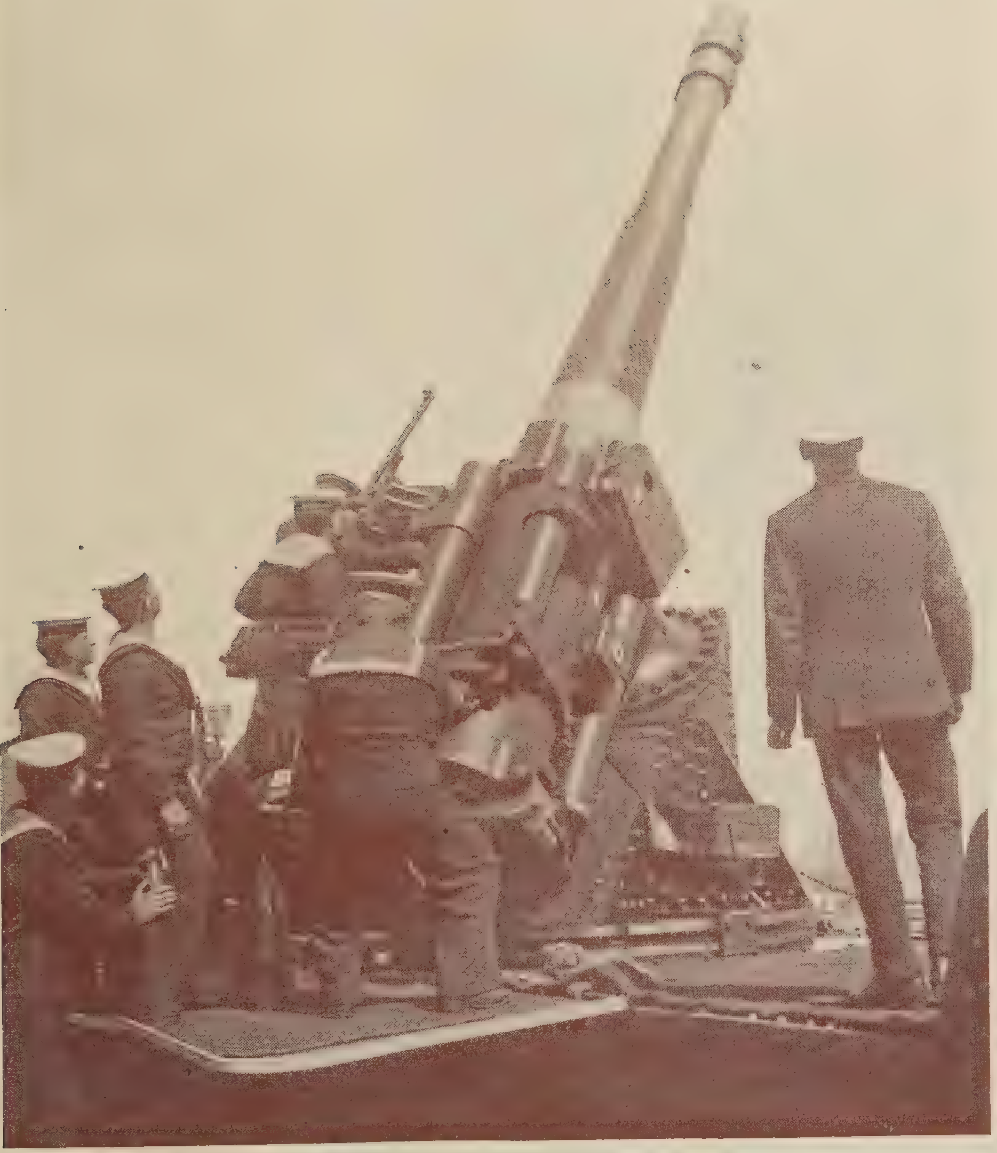
With the War came a far more difficult problem than just fining as a protest the trespassing aircraft. It became more than a mere policeman's job when hostile aircraft flew over England, dropping bombs to kill peaceful inhabitants and destroy property. At first the only weapon of defence was the rifle, to be superseded shortly by a hastily converted high-angle gun, with inefficient sighting arrangements and ammunition. Hasty provision had to be made to meet an emergency that no one had foreseen.

The first thing was to design a gun-mounting which would enable the weapon to fire directly overhead. This in itself was a problem of some complexity, because no modern gun had fired at a greater angle of elevation than from 10 to 15 degrees, and to fire at 90 degrees was a big alteration. Having got a gun with sufficient elevation, it became necessary to design a new kind of sight with which to aim accurately at moving aircraft. In the early days it was considered near enough to aim at an aeroplane as if shooting at a fast-flying bird: the gunner pulled the trigger and hoped for the best, and the best was generally a miss. With a greatly improved "sight," the shooting became better; but an aeroplane will always be difficult to hit, because the pilot has a bad habit of altering his course just as you pull the trigger, and since a shell takes some time in flight, it generally arrives in the place where the aeroplane should be, but isn't.

Not only was it necessary to obtain an efficient sight, but the question of range came into the problem; and by "range" we have to include not only distance but height. That necessitated a special range-finder to be designed, constructed and brought into intelligent use. Then, having found his range and gauged the speed of the aircraft, the gunner had to set his fuse on the shell so that it should burst, if possible, exactly on the object. All these problems had to be worked out, the various sights, fuses, etc., set and the gun loaded and fired, all within a very short space of time. Consequently the human element, which was the most important part of the combination, had to be



GERMAN OFFICERS LISTENING TO DETECT THE APPROACH OF HOSTILE AIRCRAFT.



[British Official.

THE OUTER BARRAGE.

The defence of London from hostile aircraft was to a large extent accomplished far beyond the metropolitan boundaries. This photograph shows a large naval anti-aircraft gun at practice near a coast town.

highly trained. All this took time, and during that time the raiding enemy had things in the air very much his own way.

When it came to shooting at airships another curious problem arose; how to get a shell to hit and to explode on the skin of a Zeppelin. It was found by bitter experience that the best shooting in the world had little effect on a fast travelling airship, because the air stream running from the nose aft formed a sort of cushion which deflected even the heavier type of shells. This trouble was never entirely overcome; consequently the gun was not considered to be the best weapon to employ against airships. The gun is good against an aeroplane, if only one can be sure of hitting it in a vital spot, but the average aeroplane can be fairly riddled with shrapnel, its tank pierced, its wings made to look like sieves. both pilot and observer

[French Official.

TARGET PRACTICE.

The wind keeps the small model machines swinging and at a hundred yards they look the same size as an aeroplane flying at a height, and are equally difficult to hit.

[E. N. A.

AMERICAN INFANTRY AT RIFLE PRACTICE BESIDE AN ANTI-AIRCRAFT GUN.

[E. N. A.

"ARCHIE."
A German Anti-Aircraft Mobile Gun.

injured, and yet be able to fly away home. Really the only true function of the anti-aircraft gun is to keep a raiding aeroplane or airship at such a height, from fear of being vitally wounded, that the pilot and observer are more concerned about their own safety than about the bombing of those below, and also to make any attempt at bombing a particular place or locality an extremely difficult matter.

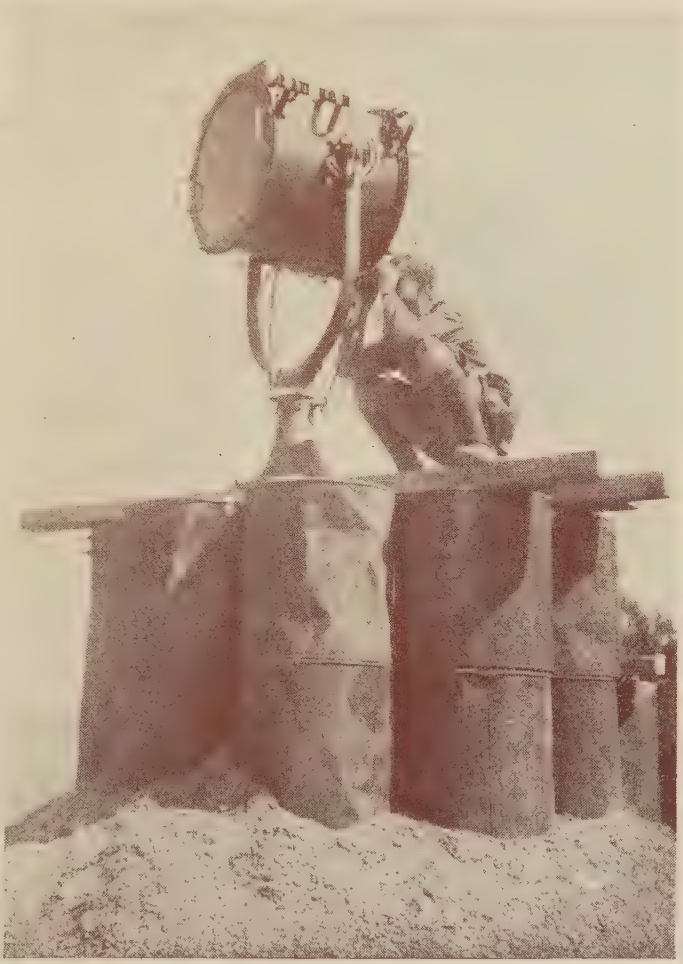
Beyond the power of seeing an aircraft, we have the power of hearing, and of the two the latter is the more important; because, whatever the weather conditions, if aircraft can fly they can be heard, and to hear is to be warned, and that is a long way towards efficient defence. Sound, however, plays all sorts of pranks under particular conditions, especially in fog, or when certain types of clouds are about. But the anti-aircraft defence forces had latterly certain sounding machines which were as nearly perfect as possible, and they played a most important part not only in warning but in directing the gunners.

[*British Official.*

BRITISH STAFF OFFICERS EXAMINING THE WRECKAGE OF A ZEPPELIN BROUGHT DOWN IN ENGLAND.

An aeroplane raid during a brilliant moonlit night presented many difficulties to the defence, because searchlights, good and greatly improved as they were, are no match for the moon, and an aeroplane flying at a great height can neither be picked out by the searchlight, nor seen with the naked eye, and hardly with glasses.

But, after all, the material devices we possessed for combating the terror that flew by night would have been of little avail without our gallant airmen. Guns, listening-posts, searchlights, and other weapons and appliances are all means to an end, to scare, annoy and keep off enemy aircraft; but it is better to destroy than to scare, and for this we had to depend more and more on the aviators themselves. It is one of the hardest things in the world to hit a moving aeroplane, though it was often done. But everyone knows how our airmen accounted for Zeppelins, time after time, and no one could keep count of the enemy aeroplanes that were brought down. So that, when all has been said, the only really sure and efficient anti-aircraft device is the British airman, a real live product of these Islands and of the Dominions, and not a machine.



A SEARCHLIGHT SIGNALLING TO TRAWLERS.

HENRY HALLING.

QUITE AN EARLY TYPE OF WATERPLANE MAKING A TRIAL FLIGHT FROM HAMPSTEAD PONDS.

[French Official.

INFLATING A CAPTIVE BALLOON.

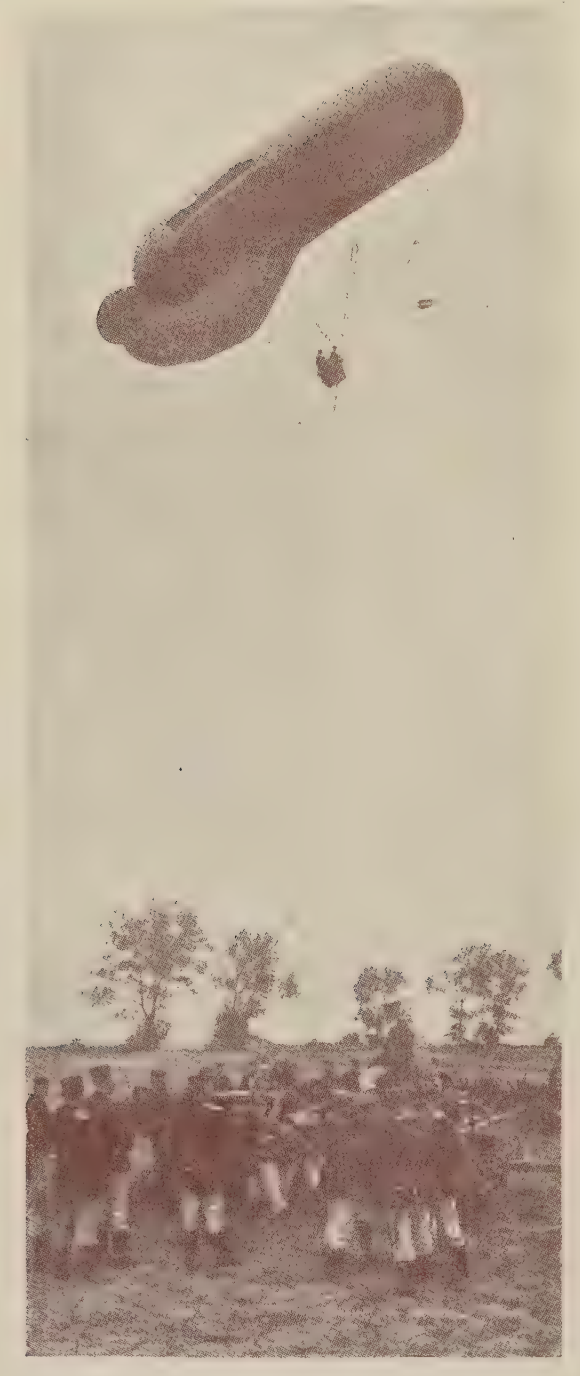
Captive Balloons and their Use in War

"IN spite of clouds and thick haze, observation was carried out for our artillery both by aeroplanes and balloons." The balloons referred to in this extract from a typical official communiqué are similar craft to those queer sausage-like objects that were to be seen almost daily during the War floating over certain suburbs of London and other places. Known as kite, captive, or Drachen balloons they were employed very extensively to direct the fire of heavy artillery.

By no stretch of imagination can they be classed as beautiful, but their extreme usefulness compensates for their ungainly appearance. Picture a little wooded declivity half a mile or so off one of those tediously direct, tree-lined Flanders roadways. The sun is breaking through the mist on the distant hills. All around the grim agents of the battle area are bestirring themselves for the day's work. The great balloon, streaked with all manner of colours to screen it, if possible, from the eyes of prying enemy pilots, is released from the numerous sand-bags that have given it anchorage for the night. A large basket-car is dragged out from the shelter of the neighbouring woods and attached to the base. The rigging is adjusted. Into the basket clamber two observers in brown leather flying-coats. With creaks and groans the ground winch pays out the necessary cable, and the balloon steadily sails up into the heavens.

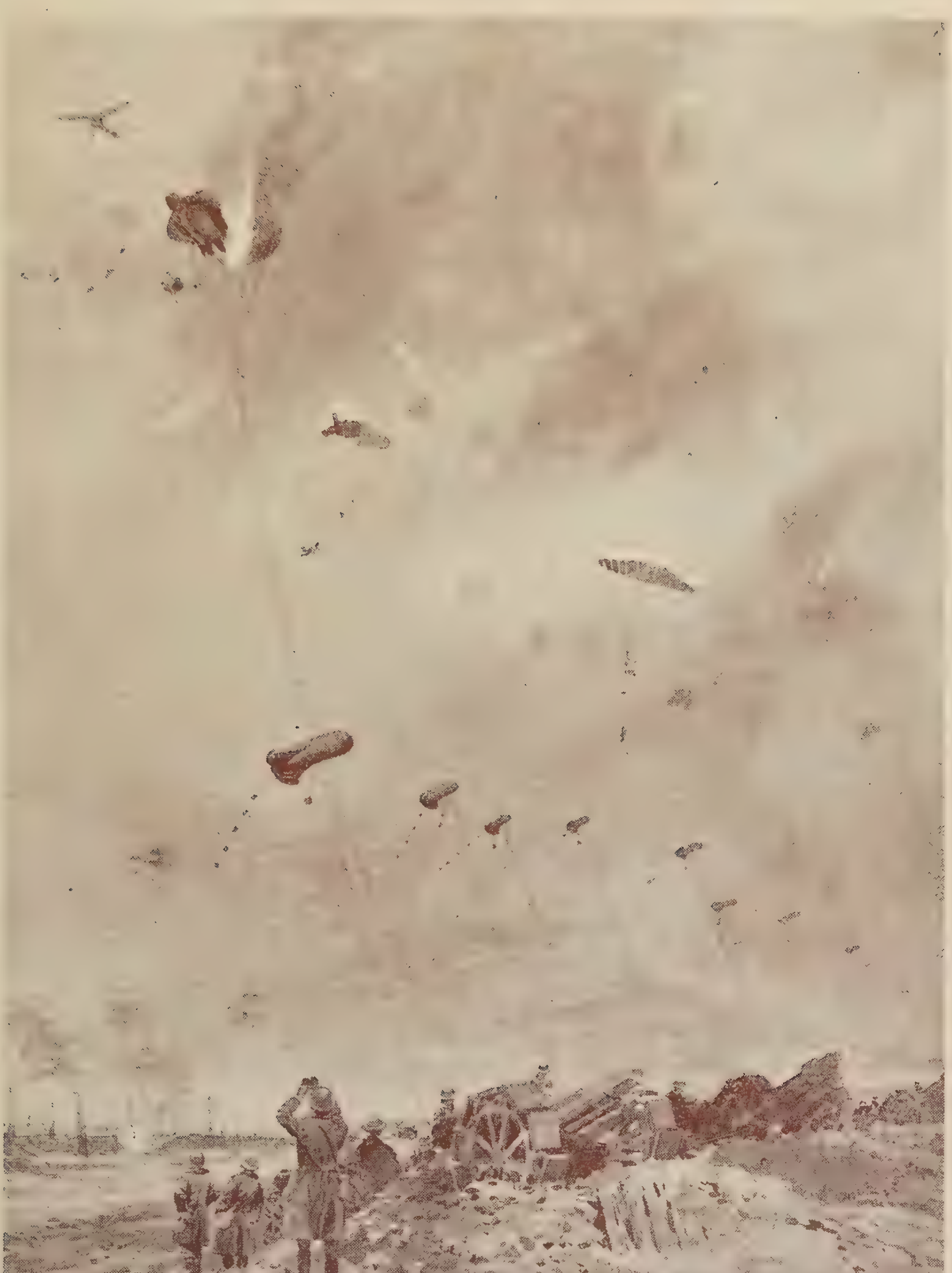
The question arises, if the same work could be done by aeroplanes, why employ these cumbrous craft, which have the disadvantage of being stationary? The explanation is that, however useful in other respects, aeroplanes can never attain the steadiness of a captive balloon. And steadiness, when one had to reckon in terms of yards on a ten mile front, is essential. A mistake might have resulted in firing into the backs of our own infantry, or in shelling an unoccupied position and thus wasting much useful and expensive ammunition.

Aloft, the two observers sit with their glasses to their eyes; now and then poring over their maps, and scouring the countryside for the objectives upon which the guns for which they are "spotting"



[E. N. A.

A GERMAN "SAUSAGE."



THE USE OF PARACHUTES.

One of a row of observation balloons has been set ablaze by an enemy airman. The observers have made use of the parachutes which every balloon carried for the purpose, and are dropping to the ground.

will shortly be ranged. Down by the winch the telephone operator will be getting into contact by wire across the countryside with the gunners, who, in their turn, are put through to the "spotters" in the balloon.

Presently there is a buzz in the balloon. The battery is speaking: "About to open fire; keep your eyes open."

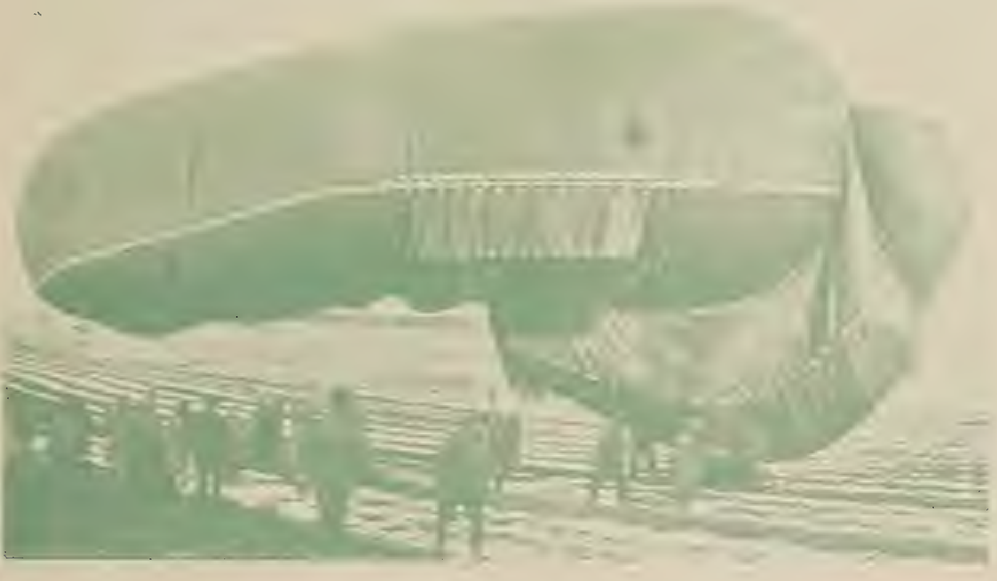
The observers concentrate on the objective, and immediately will come the reply to the guns—"Twenty yards right of the target."

[*Canadian War Records.*

OVERHAULING A KITE BALLOON BEHIND THE LINES.

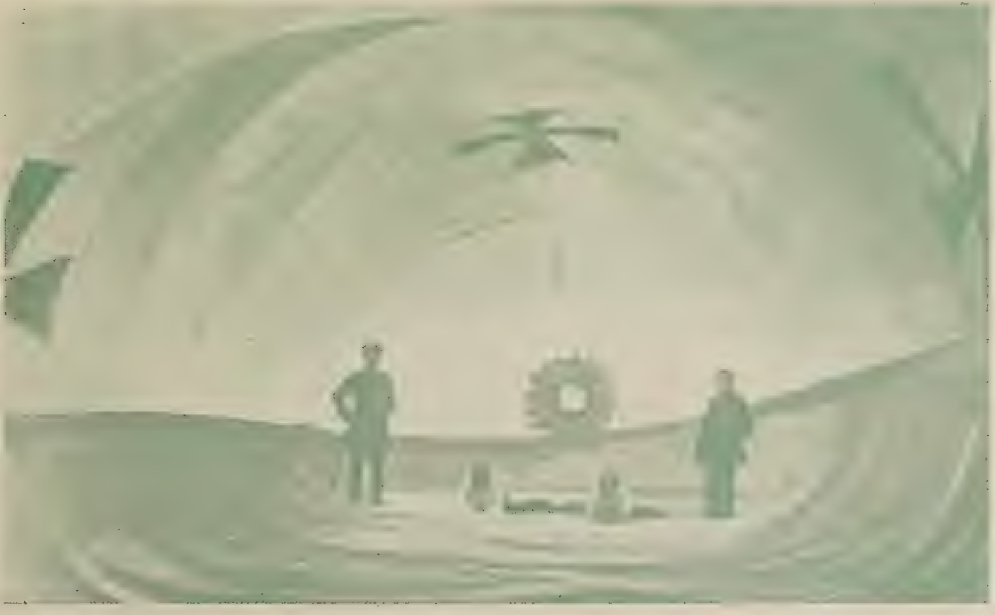
A second or so's lapse, and again there will be a burst of white and grey smoke over the distant trench, ammunition dump, or enemy headquarters, as the case may be. Again the battery will inquire, "How did my last shot go?" And perhaps this time will come the reply, "Thirty yards under," or "Fifteen yards over." Finally, with a fevered hiss, will come to the battery the welcome news, "O.K.; keep on rapid fire."

All the time the guns are firing the kite balloon will be floating



A GERMAN OBSERVATION BALLOON.

The "sausage" has come to earth for a change of observer, often necessary on account of the extreme cold.



[*Illustrations Bureau.*

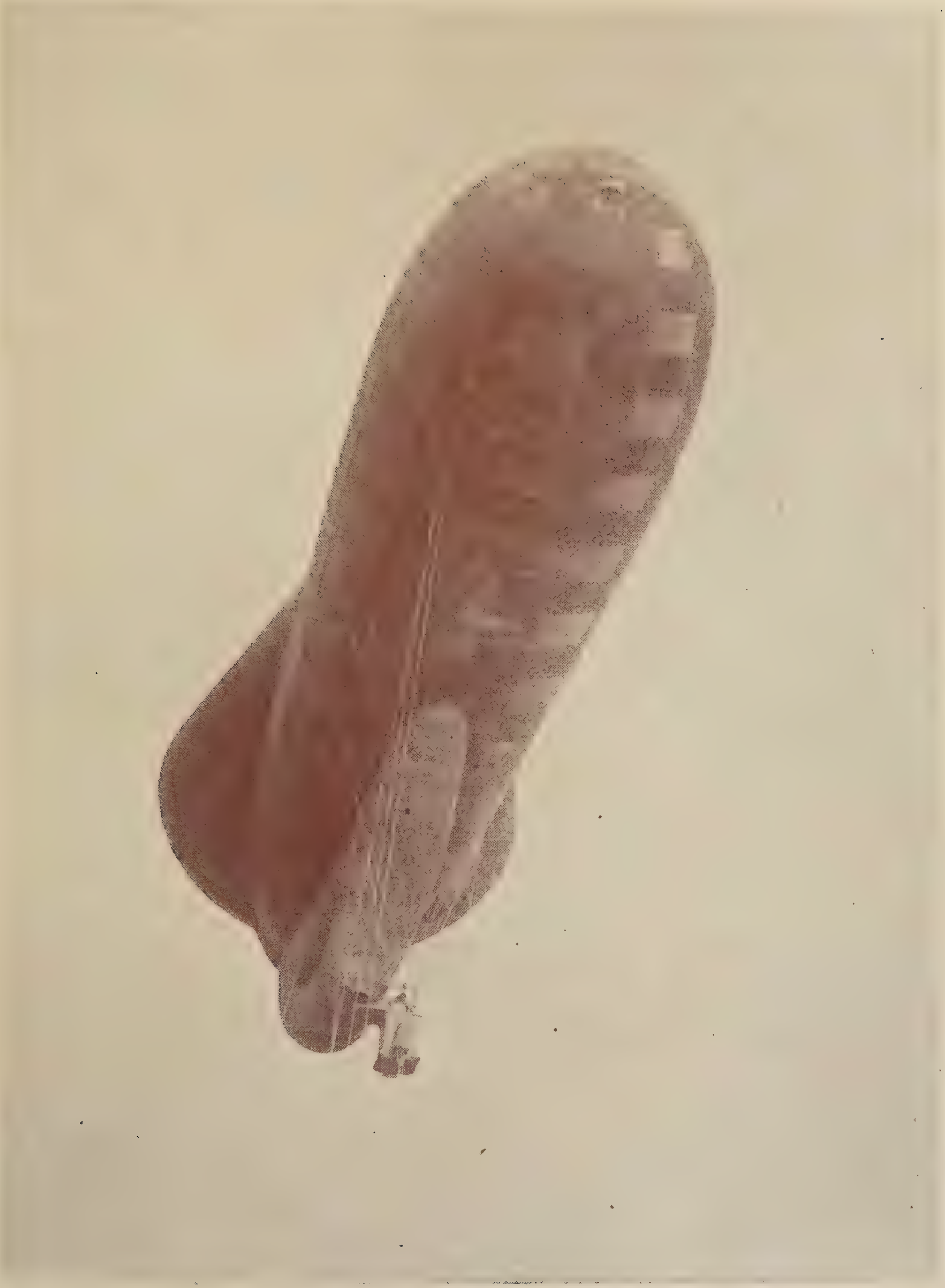
INTERIOR OF A GERMAN OBSERVATION BALLOON.

high behind them, registering their shots. And a spell of two or three hours' observation in a swaying balloon is not altogether a pleasant experience.

Long before the aeroplane came into being the establishment of every army included a number of observation balloons. The great trouble, however, with regard to their use was that they could not be kept stationary in the air. It was possible to anchor them only to one point, and when a gust struck the balloon the result was that the vessel was blown downward and down wind, in addition to which it would twirl in the air, to the great discomfort of the crew. Apart from discomfort, any observers who might be in the balloon would have all their calculations and estimates upset by a wind which would prevent them from taking measurements. For, with the balloon at a height of only half a mile, the swing produced by a wind would be sufficient to take the balloon some distance

[*Canadian War Records.*

CANADIAN OFFICIAL CINEMATOGRAPHER AND ASSISTANT READY TO ASCEND IN A KITE BALLOON.



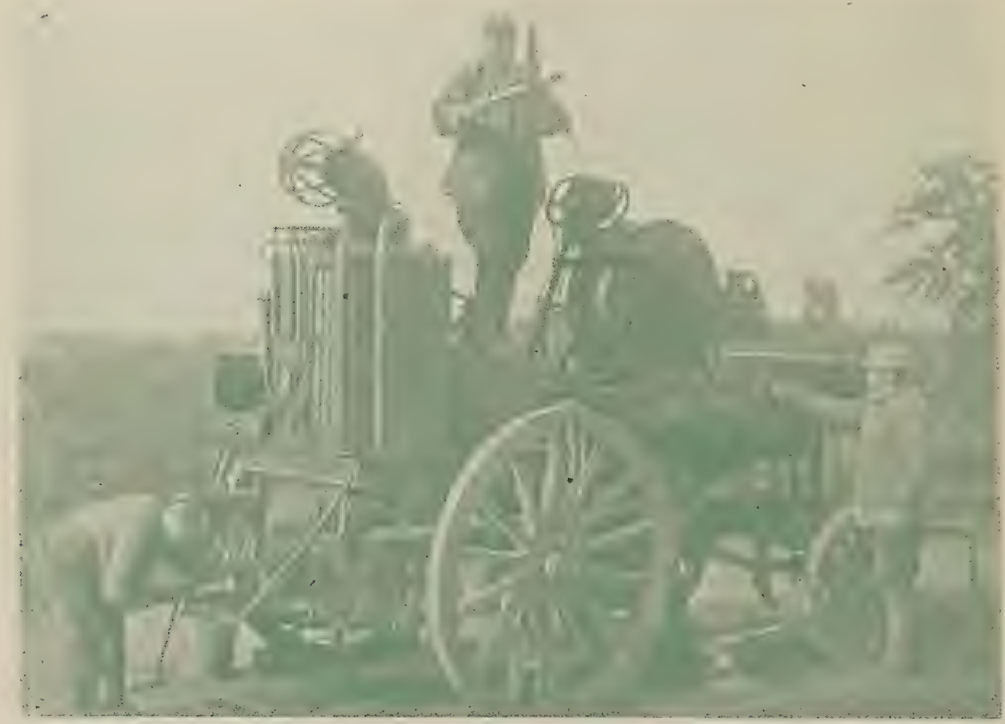
[*Canadian War Records.*

THE THREE-LOBED CACQUOU KITE BALLOON.

This type of observation balloon was invented by Captain Cacquou, of the French Army, and was largely used by our Air Force.

from its mooring station. The rotatory movement caused by wind was stopped by an experimenter who, during the Russo-Japanese War, contrived a fin, or sail, which was fixed to the balloon and acted as a sort of rudder, keeping one side of the balloon always directly towards the wind. But this did not stop the balloon from being blown away from over its mooring station, and, of course, the higher it was in the air the farther it was blown.

The difficulty was finally overcome by the German Parseval-Siegsfield Company, who devised a gasbag of which the principle was employed in the building of captive balloons by all the belligerent nations. In this form of balloon the gasbag is sausage-shaped, and, as will be seen by the photographs, is so arranged that the nose or forward end is tilted up into the wind. In consequence, the underside of the gasbag acts as a plane, and when the wind blows on it the result is a lifting tendency, which counteracts the inclination of the balloon to blow downward and away from its mooring station. At


[French Official.

A STEAM WINDLASS USED IN CONNECTION WITH CAPTIVE BALLOONS.

the lower and rear end of the balloon is a smaller bag with an opening that is kept facing toward the wind; as the wind blows into this it is inflated and thus acts as a rudder, holding the balloon steady in the air. It is not perfectly steady in a wind, of course, but nearly so, and the wind has not a quarter as much effect upon it as upon an ordinary spherical balloon.

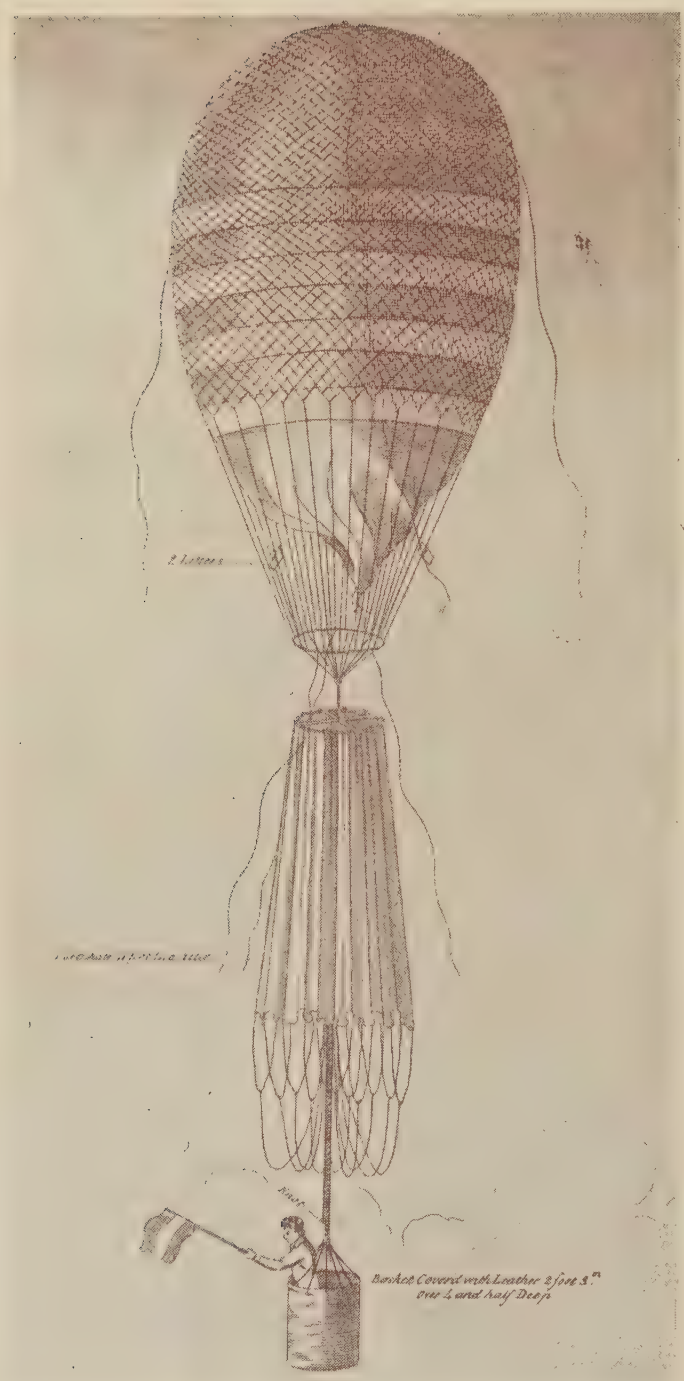
Attached by stout steel rigging, the basket-car provides space for two men, together with their instruments, maps, etc. A steel cable connects the balloon to the ground winch, and prevents it from drifting. Behind the body floats a tail of six small parachutes. These are provided to anchor the craft against any sudden gust of wind, which might pitch the observers out of the basket.

[French Official.

GAS CYLINDERS FOR INFLATING A CAPTIVE BALLOON.

If a very rapid ascent is required, instead of unwinding the anchoring cable off the drum as the balloon ascends, it is usual to unwind the cable from the drum altogether and to place it uncoiled on the ground, when the kite-balloon will ascend at a very quick rate.

Recently another shape of craft has made its appearance, the


Basket Coverd with Leather 2 foot 3 in
over 4 and half Deep

AN EARLY FORM OF PARACHUTE (1802).

This parachute—the first to be used in England—safely brought down a balloonist from a height of 8,000 feet over London in ten minutes, twenty seconds.

Cacquou balloon, invented by a captain of the French Army. Its main characteristics are a triple-bag appendage and increased stability, permitting the craft to be flown even in a full gale.

At sea observation balloons are if anything even more useful. The craft, when not in use, is stored in a specially constructed hold, and is sent up from the deck by winch and steel cable just as on land. In the Dardanelles campaign a kite balloon distinguished itself by directing the fire of the *Queen Elizabeth* across one side of the peninsula to the other. For directing the fire of big guns at sea captive balloons proved invaluable.

The one disadvantage of the craft is that it is almost defenceless against enemy aeroplanes. When these tiny grey

[Illustrations Bureau.

A PARACHUTE IMMEDIATELY AFTER LAUNCHING FROM THE CAR OF THE BALLOON.

A certain time must always elapse before the apparatus opens out.

shapes came diving down from the skies, unless there was time to draw the balloon to the ground, the only course open to the observers was to take to the parachutes, which involved a great strain on the nerves. Imagine the sensation; plunging through space at perhaps a hundred miles an hour with but a few square feet of silken fabric to prevent one from dashing headlong to the ground. For the first sixty or eighty feet, before the parachute opens, one drops like a stone. The heavier the man the sooner the parachute unfolds. When it has unfolded, the apparatus falls gently down, following the course of the backward slope of the letter *l*, at the rate, approximately, of 4 feet 9 inches per second. Really the speed of the drop depends upon the weather conditions prevailing. Thus one parachutist took 35 minutes to drop 10,000 feet, while another took over 45 minutes to make a descent of only 6000 feet.

It does not necessarily follow that all observers were expected to drop in parachutes; they were only made use of as a last resource.

The K.B. observer is trained on both ordinary spherical balloons and captive balloons. He is as much a pilot as his brother of the aeroplane, from whom he is distinguished by wearing a half-wing on his tunic. In order to qualify he has to make five trips in a free balloon across country in order to practise landing the craft, should it ever break loose from its moorings. He must also make one night trip, and a trip alone.

For a youngster thinking of taking up flying for the adventure and excitement of the work, kite-ballooning cannot seriously be advised. It is a dull job compared with the excitement of aeroplane piloting. A large part of the *personnel* was latterly composed of gunners disabled in the War. The captive balloon proved to be one of the most valuable instruments of war, and at the close of hostilities was to be found on every mile of every front.

EDGAR MIDDLETON.

[*Canadian War Records.*

AERIAL PHOTOGRAPHERS FIXING ON PARACHUTE HARNESS BEFORE MAKING AN ASCENT.

[E. N. A.

YOUTHFUL ROYAL AVIATORS.

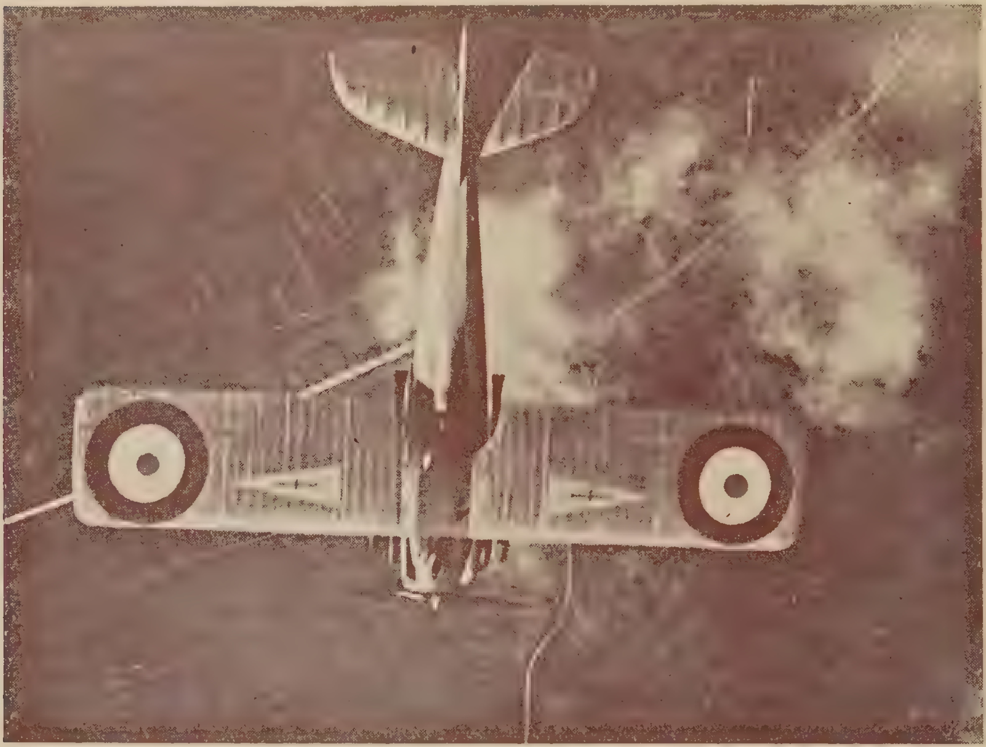
The Prince of the Asturias (Spain's future King) and his brother, the Infante Don Jaime, in an aeroplane.

Flying as a Career

IF a few years ago the suggestion had been made that a boy should adopt flying as a career, it would probably have been met by the remark that there were simpler ways of committing suicide. To-day there are still casualties among aircraft pilots, just as there are casualties in the ranks of railway engine drivers, motor drivers, and, in fact, all industrial occupations. But if you consider the casualties involved in flying, and compare them with the number of pilots employed, it becomes apparent that flying is no more risky than any other avocation.

In considering this aspect of the subject, you must rule out war casualties—that is, those incurred through attacks by enemy aircraft, by anti-aircraft fire, and the like—for they are not the risks of flying, but the risks of war; and in this respect the casualties of the flying services, generally speaking, were no greater than the casualties of a line battalion of infantry, probably not so great, considering the number of men engaged. But if one takes up flying as a career, the risks to be considered are those of ordinary, everyday flying under normal circumstances. For, whether you join either the naval or the military wing of the Royal Air Force, or whether you elect to become a purely civilian pilot, the risks are about equal with those involved in entering the Navy or the merchant service, or in training as a motor driver, or for any similar occupation.

And these risks are likely to grow less as time goes on. During the War machines had to be built with speed and attacking power as the prime factors, the factor of safety coming third in order—except that the strains on the machine were calculated for and no avoidable risk was left on that side. But in air fighting one *has* to take risks, and machines are built with a view to those risks; the peace-time machine, on the other hand, is built with a view to safety first of all, the second consideration being either speed or weight-carrying capacity, according to the purpose for which the machine is required.



[*Illustrations Bureau.*

AERIAL PHOTOGRAPHY.

A French chaser, flying at a height of about 10,000 feet, photographed from a sister machine.

The pilotage of such machines will offer a splendid career to any boy, for flying is essentially a young man's job. "Under eighteen a boy takes too many risks; over twenty-five he gets too nervy and cautious," is how the Royal Air Force instructors summarize the position. What they like best is the boy of eighteen, with a natural bent for mechanics, who has to a certain extent soaked himself in the theory of internal combustion engines, and, for preference, driven a motor-cycle or car. With these as qualifications, and no more, they like to get him and to teach him the aeroplane from A to Z, finally sending him up on his first "solo" and "cross country," reckoning that "there goes another first-class pilot."

[*Newspaper Illustrations, Ltd.*

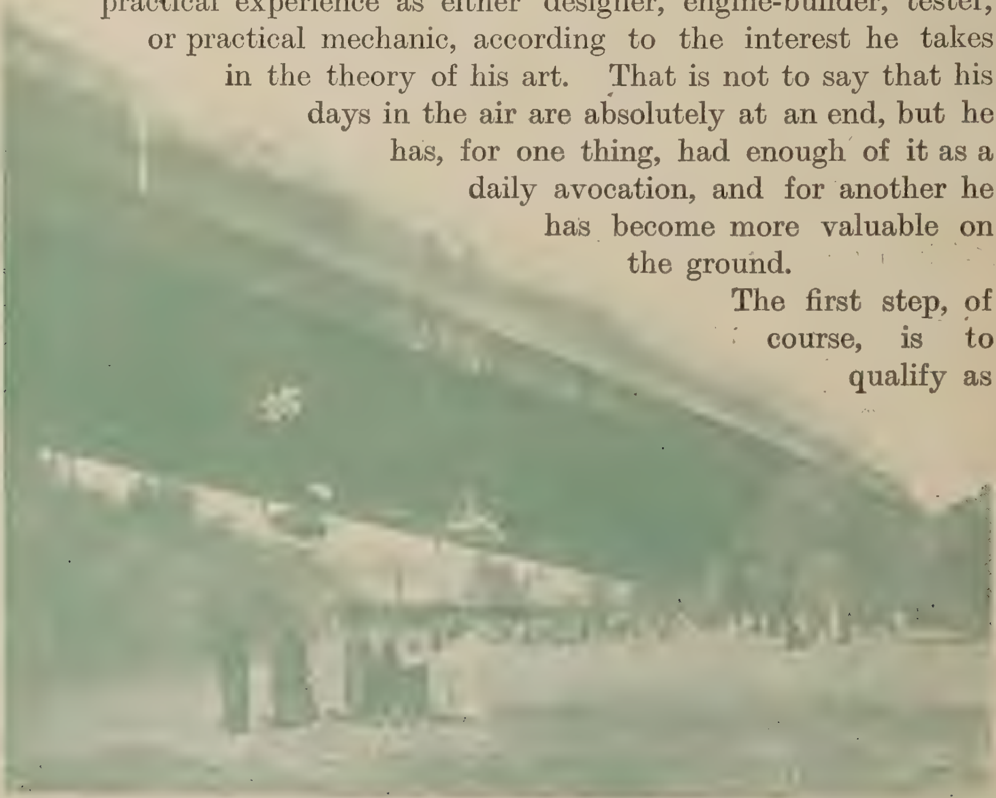
LIEUTENANT FONCK.

The famous French aviator and leader of the "Stork" quadrilla, with stork presented to him by the civic authorities of Lyons as a mascot.

That is so far as the Flying Service is concerned, and, whatever happens, there will always be plenty of room for young enthusiasts in both branches, for the aeroplane as a weapon of war has come to stay and to grow. It is more than probable that, in peace-time, there will grow up a corps of trained pilots very much in the same position as the Royal Naval Reserve of the British merchant service, men who, by being civilian flyers, keep in touch with the latest and best in design, and are ready for military or naval service on the outbreak or even possibility of war. So much for the military side; what the boy of to-day has to consider is the purely civilian and commercial aspect of the business.

Civilian flying had hardly begun to shape itself when the War came along and hustled up design, altering it here and there, and developing the machine; but civilian flying will progress almost as quickly now that peace conditions make manufacture in quantities possible for other purposes than war, and the pilot of to-morrow will be the constructor and the tester of the day after to-morrow. For a pilot's "life" in the air is short under any conditions; by the time he has done three or four years he has generally had enough of it as a regular thing, but at the same time he has qualified himself by practical experience as either designer, engine-builder, tester, or practical mechanic, according to the interest he takes in the theory of his art. That is not to say that his days in the air are absolutely at an end, but he has, for one thing, had enough of it as a daily avocation, and for another he has become more valuable on the ground.

The first step, of course, is to qualify as



[French Official.

A ZEPPELIN BROUGHT DOWN AT BOURBONNE-LES-BAINS AFTER ATTEMPTING TO DROP BOMBS ON LONDON.

COAST DEFENCE :
The Raiders' Fate

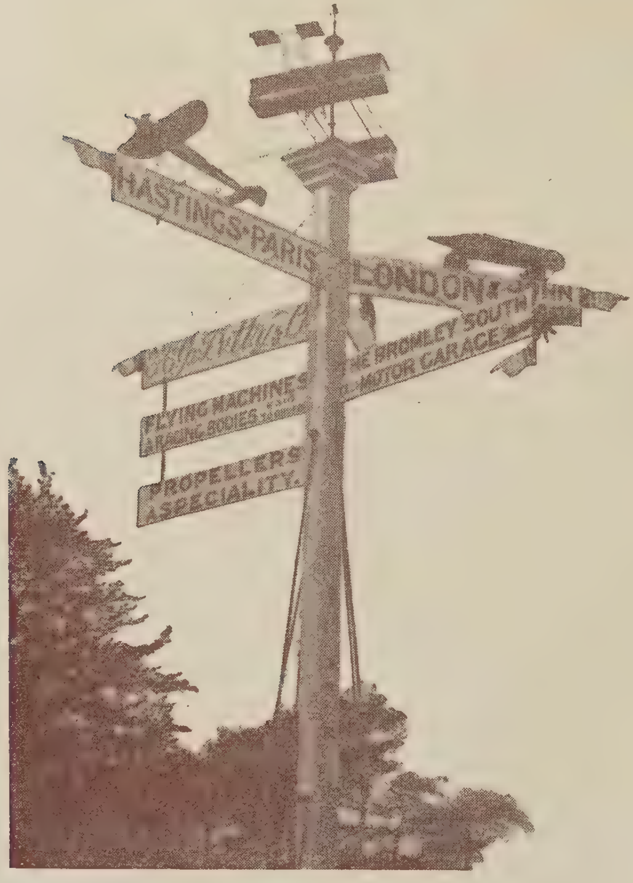
[*Underwood & Underwood.*

THE SHEET METAL DEPARTMENT OF AN AMERICAN AIRCRAFT FACTORY.

a pilot, in the manner described in the article "Learning to Fly," but the boy who wants to "make good" at flying should not consider that the end of his training. He can go on teaching himself bits about design and engine use and fitness—there are hosts of text-books available, and there is no study more fascinating if one has a little mechanical aptitude. There is, too, no limit to the positions he may acquire; men whose names are known throughout the world to-day in aeroplane construction were, a few years ago, struggling pioneers at one or other of the flying-grounds, with far more faith than money. The life stories of Watt and Stephenson are no greater romances than those of yesterday's flying pilots, many of whom are now at the head of great industries.

Now that the War is over young fellows will not need to stick to Service work (though that undoubtedly provides the best and most varied training), for there are certain to be hundreds of openings in commercial flying where trained and efficient pilots will be wanted. Regular air services are being established for mails and various purposes; and each service will demand a certain number of pilots, supervising heads of stations (who will be required to possess practical working knowledge), men in the administrative branches, men in charge of engineering departments (where again practical working knowledge will be essential) and inspectors of various sorts. Then there are the big constructing firms, who must have testers of new machines and men who have made a study of design and construction. Hundreds of openings will be available in course of time, and, as in every great commercial development, the man who has been trained from boyhood is the one who will take precedence.

A score or so of years ago the motor vehicle for road-running was in the position of the flying vehicle to-day; it was just at the beginning, a matter of possibilities rather than of realities. To-day the motor industry absorbs the energies of thousands of men, and those who have had experience from the early days are the men who count.



[*Illustrations Bureau.*

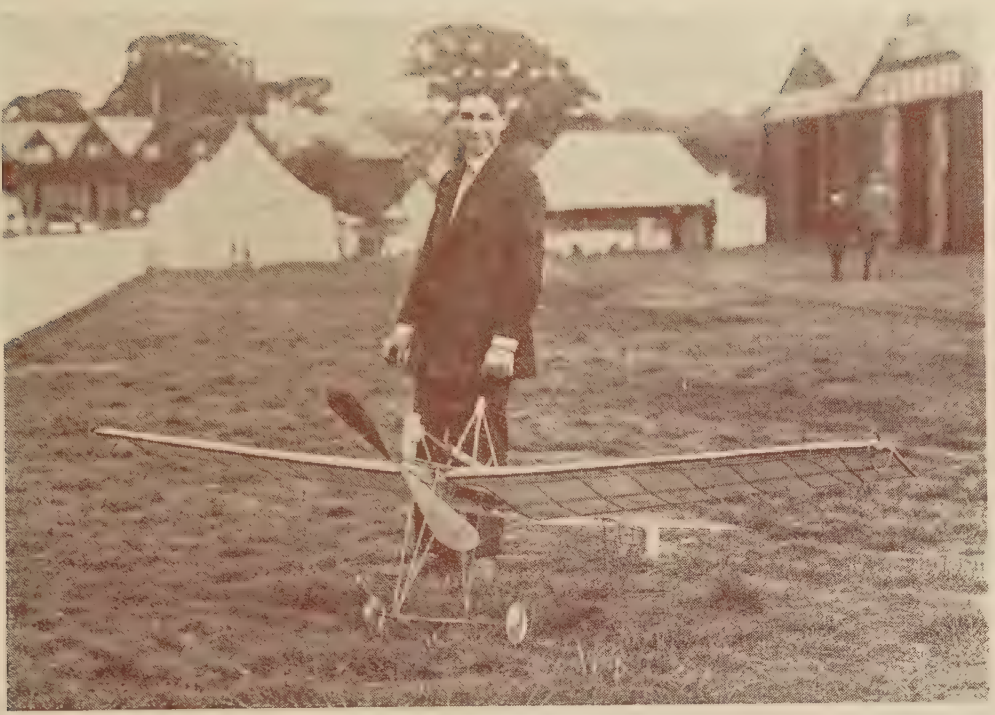
A SIGN OF THE TIMES.

On this unique signpost a model aeroplane points the way across Channel to Paris, and a motor-car the road to London and John o'Groats. The wind indicator is a seaplane.

No man a few years ago could foresee the tremendous developments of motoring, and in the same way no man to-day can altogether foresee the developments of flying. But it is certain that the boy who is willing to work hard and to study hard will find few better or more interesting careers than that of which a "flying ticket" is the start.

The sailor, who claims to see a good deal of the world, sees only the coastal ports; the flying pilot of the future will be able to see the whole world while at his work.

D. S. MANN.



[*Topical Press.*

TESTING A MODEL NIEUPORT MONOPLANE.

This model had a span of 8 feet and was 6 feet 6 inches in length. It was driven by oxide gas, and flew for a mile.

Model Flying Machines: How to Make and Fly Them

THE making and flying of model aeroplanes is one of the most popular and fascinating of hobbies. It is now possible in our fields and meadows to reproduce on a smaller scale many of the evolutions of the full-size machine, and we are thus enabled by practical experience to learn the "why and wherefore," and to study for ourselves many of the most interesting problems in connexion with artificial flight. We can now build miniature aeroplanes that will rise off any smooth surface, such as a cricket pitch or a plank, and fly at least four hundred yards at an altitude of from fifty to sixty feet; while many of the hand-launched machines are capable of flying nearly half a mile. It is also quite easy to make model seaplanes that will rise off the surface of water, although, owing to the extra resistance of the floats, it has not yet been possible to obtain quite such good results from this type of model. Biplanes and triplanes, tiny machines for flying indoors when the weather is unsuitable for outside flying, and models of machines which ascend vertically in the air (known as helicopteres) can all be made with comparative ease.

Penaud practically created the present form of model aeroplane, and from his time onward it has been used extensively for experimental purposes, and, as records go to show, has been of great value and assistance.

Prior to the War the record for distance off ground (model to rise from ground under its own power) was 888 feet; for duration off ground, 80 seconds; for distance hand-launched, 1770 feet; for duration hand-launched; 89 seconds; while the record for models rising from the surface of the water stands at 450 feet distance approximately, and 37 seconds duration. These records have since been much improved upon, the record for duration now standing at 2 minutes 49 seconds. Records have also been made for power-driven machines, but those mentioned constitute the most important. The records for distance and duration (time) are held by different machines, as regards type, dimensions and general details.

In various parts of the country aero clubs have been formed by enthusiasts. Where a number of aeromodellists reside close together it is, of course, much better for them to form a club, because each may then profit by others' successes and failures.

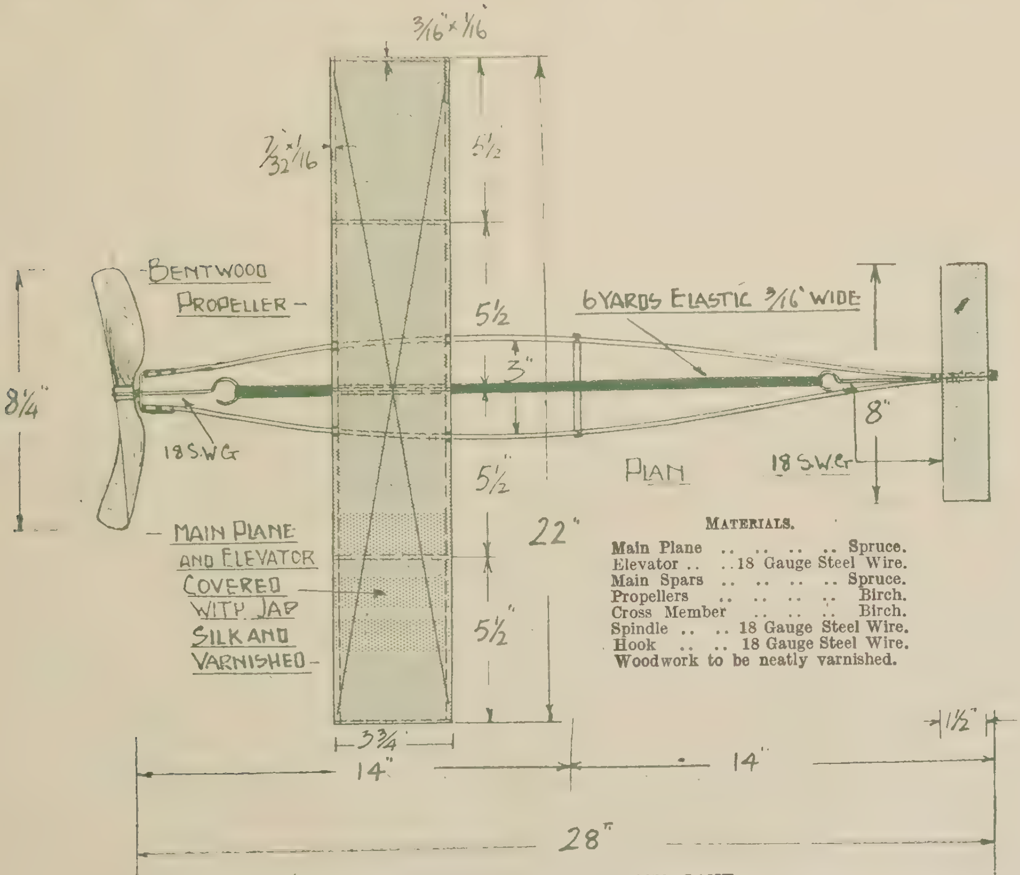
I propose to describe the construction of two simple long-distance models. I shall not mystify the reader with theoretical explanations, preferring to let him construct and fly the machines primarily for pleasure, in the hope that he may thereby be led to discover and study some, at least, of the principles underlying mechanical flight; for it must be remembered that the principles governing the flight of a model apply equally to a full-size machine.

Nor are the machines beyond the mechanical ability of the very beginner, and it is possible for all the parts to be made with very few tools indeed. A pair of pliers, a small chisel and a hammer, one very fine bradawl and an ordinary fretwork plane, comprise all the tools required.

Some of the materials, however, can be bought so cheaply that it will hardly be worth while to make them. I refer chiefly to the wood for the mainplanes and propellers, and also the wooden frame, or fuselage, members.

A SIMPLE SINGLE-SCREW MONOPLANE

A glance at the drawings will convey the form and general arrangement of this model. It is a single screw monoplane, and it flies with the propeller *behind*, not leading, as in most of the full-size machines. In other words it is a "pusher," not a "tractor." The screw is placed in the rear because it is much simpler to fly the machine thus, and not nearly so much adjustment is necessary.



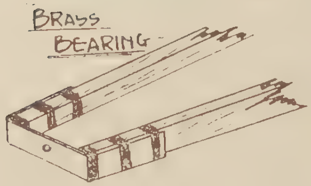
MATERIALS.

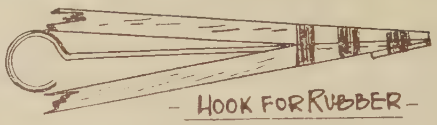
Main Plane	Spruce.
Elevator	18 Gauge Steel Wire.
Main Spars	Spruce.
Propellers	Birch.
Cross Member	Birch.
Spindle	18 Gauge Steel Wire.
Hook	18 Gauge Steel Wire.

Woodwork to be neatly varnished.

A SIMPLE SINGLE SCREW MONOPLANE.

The first thing to do is to plane the wood for the frame, or body, to the sizes shown on the drawing. Great care must be exercised to ensure that both pieces are of exactly the same length and section, so that they are of the same weight. It is a good plan to weigh each member separately, gradually planing a shaving or so off the heavier until they are equal in weight. The pieces can be finished up smoothly with





fine No. 00 sandpaper. It will be noticed that the frame members taper slightly off towards each end. This is to prevent the completed frame from buckling or twisting under the stress of the elastic motor.

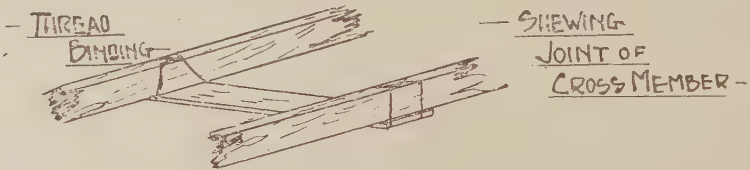
A narrow strip of brass will next be required to form the bearing, as sketched. It should be about $\frac{1}{32}$nd of an inch in thickness, the two lugs which engage the frame members being so bent that they follow the contour, or curve, of the bowed frame. A $\frac{1}{16}$th hole must be drilled in the centre for the spindle of the propeller to pass through, as will be seen from the plan view.

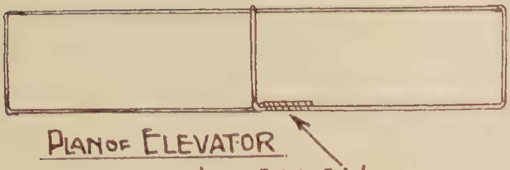
The bearing is to be tightly bound to the members with black three-cord carpet thread, the thread being afterwards smeared with weak glue to secure it. It should be lashed after the manner of the binding on a cricket bat and the ends pulled through out of sight.

Now bend to the shape shown in the sketch the hook which passes through the nose of the machine, and to which the other end of the elastic skein is attached. It will be clear from the sketch that its end is bent round flush to the frame member, and is tightly lashed and glued into position. Before the two frame members can be bound, however, they must be cut off to an angle as shown in the sketch.

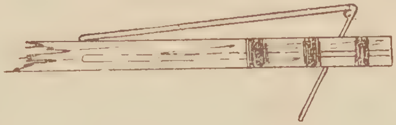
We now have the bearing and the hook attached; it only remains to bow the frame to complete it. This is effected by fixing a cross member, also shown in perspective detail, across the frame and firmly securing it by pins, glue, and binding.

The elevator is formed from either piano or tinned iron wire—the former for preference, since it is more durable and not nearly so likely to buckle should it receive a knock during flying. It is made in one piece, as a glance at the elevator plan will show. The centre rib continues over the leading edge, being bent downwards and backward, as shown in the sketch of the centre rib of the



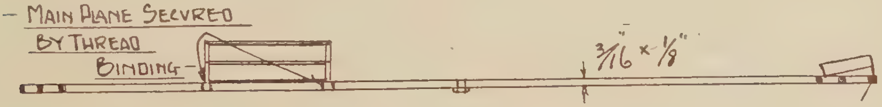


PLAN OF ELEVATOR



— CENTRE RIB OF ELEVATOR BENT BACK TO ANGLE —

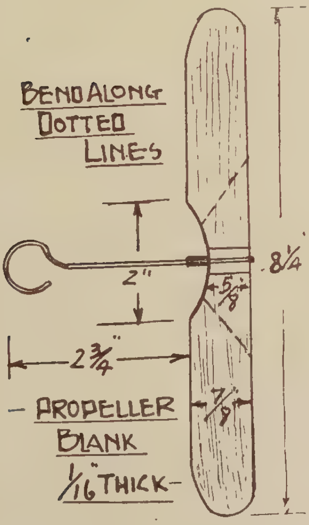
elevator. This projecting spoke provides the means of securing the elevator to the frame. It is passed through a hole drilled in the nose of the frame so that the spoke is a nice fit within it; the spoke being bent back at an angle, causes the trailing edge of the elevator to bind on to the spar. No further security will be found necessary, as the elevator will remain quite rigidly in place



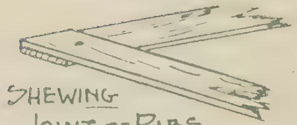
SIDE ELEVATION

during flying, although, should the model strike a tree, wall or other object, it will swivel round and so will not be damaged. The joint in it (which, it must be noticed, is located at the centre of the back, or trailing, edge) must be bound with fine florists' tinned wire and lightly soldered. It will also, of course, require to be soldered where the centre rib passes over the front, or leading, edge and continues downward to form the adjusting spoke. Finally, carefully true it up with the pliers so that it lies quite flat.

So much for the elevator; we can now turn to the main plane. This is built up of thin strips of wood pinned and glued together as shown in detail. The best method to adopt for its construction is to leave both spars and ribs a trifle longer (say half an inch) than necessary, so that they do not become split during the pinning operation. Mark ribs and spars off to correct lengths and pin them together, placing the ribs on the *top* of the spars, smearing glue



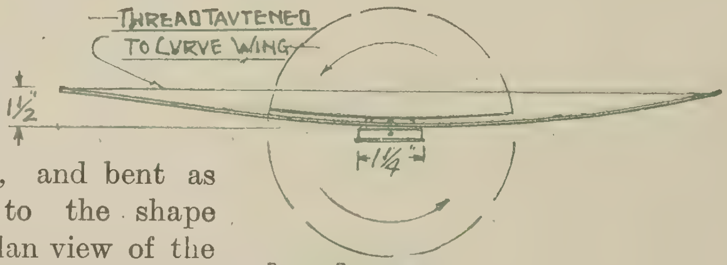
— PROPELLER BLANK 1/16" THICK —



SHEWING JOINT OF RIBS IN MAINPLANE

with a camel hair brush between the joint, and driving the pins right through into the bench.

The plane should be left thus secured until the glue has thoroughly set, when it may be prised up with the blade of a pocket-knife, the pins bent over or "clinched" into the spars, by tapping them back with a small hammer (the wing being supported on an iron block during this operation), and the ribs then trimmed off flush with the spars. Carefully remove with fine sandpaper any sharp edges which might tear through the fabric, and the wing frame is complete.

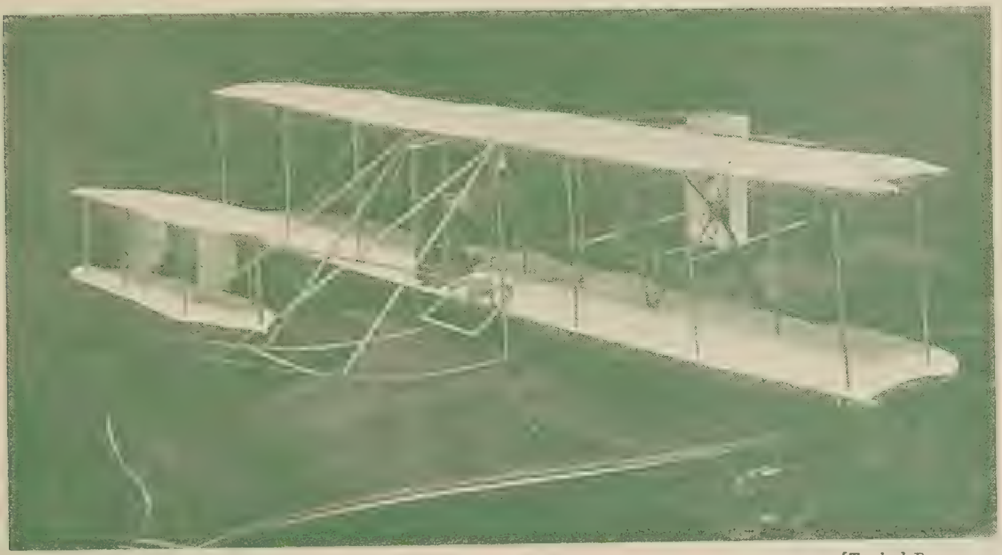


END ELEVATION

It will be the better plan, I think, to complete all the components before covering the two planes, so we may proceed to the final and, be it said, the most important part of the machine, the propeller This is to be cut from very thin wood (birch for preference), of the shape and dimensions shown, and bent as explained below to the shape indicated in the plan view of the model. Around the centre of the blank a tin strap is to be soldered, and on to this, in turn, the shaft is also soldered. It must be clearly understood that the shaft passes over the centre of the blank, and thus must be soldered to both sides of it. Before forming the hook, a short length of brass tubing must be slipped on the shaft to act as a distance bush to allow the propeller to clear the frame when it is revolving. Now hold the blades in a jet of steam and gently twist along the dotted bending lines shown in the drawing until, under the warping effect of the steam, it remains where twisted. One blade only must be operated on at a time, and each must be bent to exactly the same degree. Too much care cannot be expended on the making of the propeller, for on its efficient working the whole success of the machine depends.

Readers who prefer to buy a propeller can do so from any of the London model-dealers for sixpence, although it is obviously more interesting for the reader to prepare his own. Take note that the screw is made to revolve in the direction of the arrows in the end elevation of the model. When satisfied that the propeller is quite true, it can be sandpapered and polished with a couple of coats of good coach varnish, and then left to dry.

Reverting now to the question of covering, nothing better or lighter can be used than yellow Jap silk, which, when varnished, is of a rather pleasing golden hue. It can be purchased quite cheaply, costing about 1*s.* 8*d.* per yard, and as only half a yard will suffice the cost of fabric will not be great. The edges of the fabric are to be glued along *underneath* the spars, so as to present a neat top appearance. First, cut the fabric out to size, allowing sufficient to pull under the spars, and then glue it to the under surface of either of the two end ribs and leave to dry. When set, pull the fabric tautly over the frame so that the latter bends up slightly as shown in the end view, and glue along under the second end rib. The bowing up of the frame, it will be noticed, has a tendency to prevent this end from sticking, so drawing pins must be inserted, being pressed partially home into the rib until the glue has set. Finally, stretch the fabric over the leading and trailing edges of the plane, using drawing pins as before, and taking care that all wrinkles in the fabric are effaced. All rough edges should be cut away with the scissors. In order that the main plane may maintain its upward curve as shown in the end view it is to be diagonally braced with carpet thread.



[*Topical Press.*

MODEL OF THE HON. C. S. ROLLS' MACHINE, IN WHICH HE MADE THE FIRST FLIGHT ACROSS CHANNEL FROM ENGLAND TO FRANCE AND BACK AGAIN WITHOUT LANDING.

With regard to the elevator, it will be found expedient to sew the fabric to this, first pinning it tautly into place and then securing it with an over and over stitch.

We now arrive at the proofing stage. I cannot lay too much stress upon the importance of making the covering thoroughly impervious to air, as that is where so many beginners go astray. The fabric *must* be quite airtight. The best proofing to use is good varnish, slightly diluted with turps to dry it more quickly. This mixture should be thinly and evenly applied with a flat brush, one or more coats being given according to the appearance of the fabric after the first. The planes must be viewed after proofing (or "doping") for pores, and it is upon the presence or otherwise of those pores that the necessity for a second coat depends.

When the wing is thoroughly dry it may be bound to the frame (which should previously have been varnished), as shown in the side elevation. As will be obvious, the binding passes over the spars of the wing and round the frame members, and thus secures it.

Now place the elevator in position, with its front edge about an eighth of an inch off the frame, as shown in the sketch of the centre rib (the trailing edge, of course, being down on the frame), pass the propeller spindle through the bearing, and attach the skein of rubber to the hooks. By the way, make quite sure that the correct elastic is procured, that is $\frac{3}{16}'' \times \frac{1}{32}''$. The hooks can also be conveniently covered with cycle-valve tubing to prevent them from cutting through the rubber. All joins or breakages in the latter must be repaired with thread, the elastic to be stretched while being bound with it.

Before we can actually fly the machine we shall require some rubber lubricant. This is used to prevent the strands from adhering to one another, and also to enable more turns to be given to the skein, which means, of course, more power. The ingredients are soft soap and glycerine in the proportion 6 : 1, well boiled together and allowed to cool. When smeared upon the strands of rubber this solution has the desired effect of rendering them slippery.

And now with regard to the actual flying of the machine.

In the first place the model must be glided, to adjust its balance. Hold it aloft just above the head, the left hand supporting the front and the right grasping the propeller. Impart a gentle forward thrust to the model with the right hand, at the same time releasing the left.

As the right arm comes forward, release the machine, and if it is correctly balanced it should glide to earth at a very slight angle. Assuming, however, that it has a tendency to dive, then the mainplane must be moved forward. If, on the other hand, it has a tendency to rise, the mainplane must be moved to the rear. This adjustment, of course, necessitates the removal of the binding holding the main plane to the frame. Hence I would suggest that it be only temporarily lashed in the first instance to facilitate its being quickly adjusted on the field. Unless the tendency to dive or ascend is abnormal, the mainplane must not be moved more than $\frac{3}{32}$nds of an inch, in either direction, at a time.

Having by this means obtained an even glide, the model can be tested in actual flight by giving the propeller from 100 to 150 turns in the correct direction, which must be such that the screw, when unwinding, drives a volume of air from the rear end of the machine. There is a very erroneous idea prevalent among beginners that a propeller may be wound in either direction. Such is not the case, as the reader will see if he endeavours to fly the machine with the screw wound the wrong way round.

[*Topical Press.*

MAKING A MODEL TRIPLANE.

To launch the model grasp the screw in the right hand and support the nose with the left, as if about to glide the model. Then thrust it forward with the right, at the same time releasing the left; and when the right has travelled sufficiently far forward that, too, may be released. If all is in order, the model should rise and fly steadily.

Should it tend to dive slightly, or to "stall" (rise at too steep an angle) then similar adjustments as were made when gliding are required. Once the most favourable position for the wing is found it can be permanently bound there in the manner already described, and any small adjustments necessary afterwards can be effected by altering the angle of the elevator by pushing the spoke passing through the frame upward to increase the elevation or downward to lessen it.

A TRIAL FLIGHT. [Topical Press.

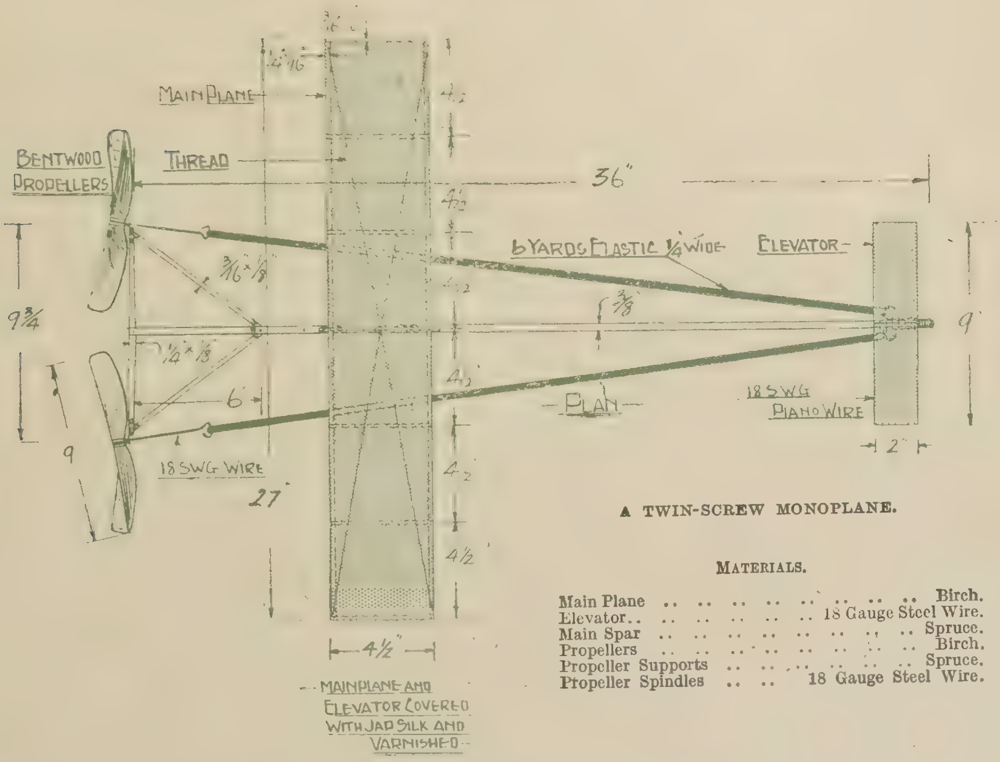
The maximum number of turns the elastic will stand is 350, and this number should be gradually worked up to, and not applied until you are quite certain that the model is correctly adjusted.

Keep the bearing well vaselined, lubricating the rubber every third or fourth flight; and if the model has been made according to these instructions, circular flights of from 150 to 200 yards should be easily obtained.

Should the propeller have a tendency to chatter during revolution the propeller shaft must be adjusted until it revolves truly.

A TWIN-SCREW MONOPLANE.

The twin-screw monoplane illustrated is just a little more difficult than the machine described in the preceding pages. It will carry the reader a little beyond the constructional ability required for that machine, but it should afford him an opportunity of applying the experience gained thereby. This machine, it will be observed, possesses twin screws, revolving in opposite directions. These are fitted in order to obtain as straight a flight as possible. Those who have built and flown the model first described will have noticed that it had a tendency to fly in a circle, in an opposite direction to that in which the screw revolves. This is, of course, a difficulty that can be got over in many other ways, but it follows that if we use twin propellers revolving in *opposite* directions each will balance the twisting effect of the other. Whatever other methods we may employ, this is the most mechanical.

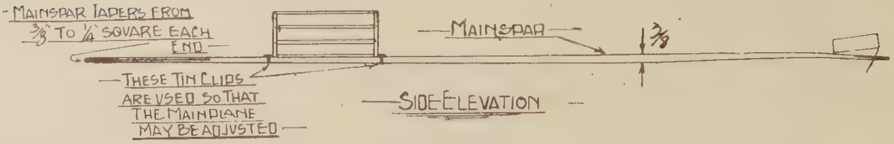


A TWIN-SCREW MONOPLANE.

MATERIALS.

Main Plane	Birch.
Elevator	18 Gauge Steel Wire.
Main Spar	Spruce.
Propellers	Birch.
Propeller Supports	Spruce.
Propeller Spindles	18 Gauge Steel Wire.

This design is one that is, in a more elaborate form, much in favour with some of our crack aeromodellists. In fact, I believe it has figured


MAINSPAR TAPERS FROM 3/8" TO 1/4" SQUARE EACH END
MAINSPAR
3/8
THESE TIN CLIPS ARE USED SO THAT THE MAINPLANE MAY BE ADJUSTED
SIDE ELEVATION

more in open competitions than any other. This is not surprising, for from the point of view of those who fly models for sport (and an excellent form of sport, too), better flying results could hardly be desired. The minimum distance this model should fly is 300 yards at an altitude of 40 to 60 feet.

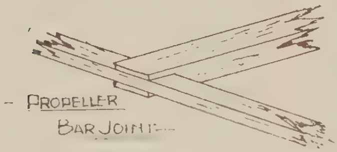
The plan view will show the principal dimensions and the general arrangement. The twin screws are driven by two skeins of elastic, disposed diagonally in relation to the mainspar.

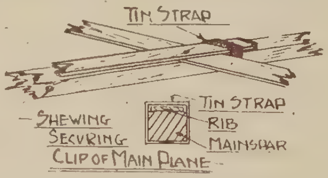
It will be seen that the frame is of the T pattern, so called because of its resemblance to that letter. The two propeller bearings are carried on a bar, which is supported by two diagonal struts.

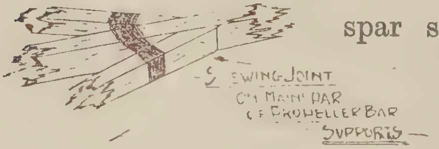
It will be best to construct the frame first. Carefully taper the mainspar as shown in the drawing, and then with a narrow chisel or fretsaw cut a slot in one end to receive the propeller-bar, as sketched in detail. Make the propeller-bar a tight fit within the slot, and then pin and glue it into place. A sketch is also included of the joint of the propeller-bar supports, which clearly indicates that it is pinned and bound into place. All binding should be saturated with weak glue so that it remains secure. It is essential that the propeller-bar support joint should be a sound one, because it has to withstand the tension of two skeins of rubber, and this is considerable.

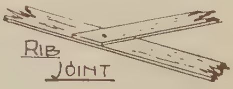
To each end of the propeller-bar a small brass bearing is attached (made from similar brass to that used on the single screw model) by tight lashing and gluing.

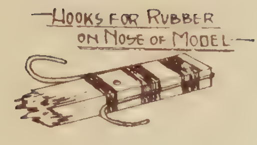
Twin hooks are fitted to the front of the frame as shown. The hole for the elevator adjusting spoke (shown also in the drawing) must not be drilled until after the hooks are bound in, as there is less likelihood of the spar splitting during the insertion of the drill. In this machine,











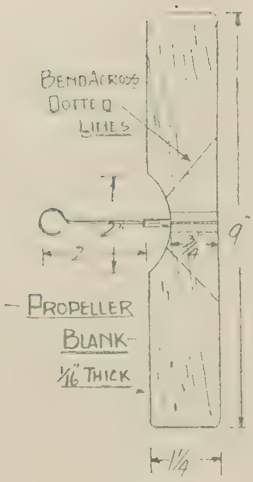
it will be seen, a different method of securing the main plane to the spar is employed. The centre rib continues over the edges of the spar, and is clipped to the latter by means of tin clips or sockets. This permits of the wing being readily adjusted or removed, and at the same time provides a rigid wing security. I have shown the detail in perspective, as well as in section, so that it shall be quite clear. The tin strap should be tightly pulled round the rib and spar before it is soldered up, to ensure that the plane will not be loose within it.

The main plane and elevator are made in a similar manner to those used for the first machine, the ribs and spars being left longer than necessary to be trimmed off flush when the glue has set. In covering the mainplane use great care to ensure that the plane does not become warped owing to the fabric being pulled too taut. Varnish and turps are again to be used to proof the wing, two coats being given if necessary. When the plane and the elevator are fixed it is necessary to sight along them to see that they are in line with one another. A view of the end elevation will reveal clearly what is meant.

The mainplane is to be diagonally braced to impart the upward curve; the ends of the bracing threads are passed through small holes drilled through the spar, just inside the end ribs, and then knotted. Carpet thread or fine Jap gut is suitable for the purpose. If the reader has prepared his own wood, the bracing of the main plane will at once reveal any thin spots in the spars, by showing a broken curve. It is most important that the wood should be planed of, uniform thickness.

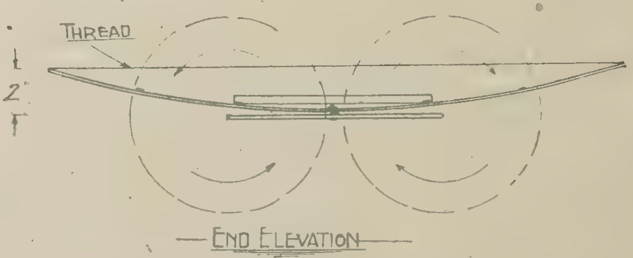
The bending of the propellers will require special attention because they are of opposite pitch, which means that we have four blades to bend at the same angle and at the same position in relation to the spindle. If, however, the reader keeps before him the plan view of the screws during bending I do not think he can go wrong. As with the previous machine, bend along the dotted lines, finishing one blade at a time, and do not try to twist two at the same time. After bending they must be thoroughly dried in front of the fire to draw out all moisture from the grain.

In flying the model remember that the propellers must be wound in *opposite* directions, and that each *must* be wound exactly the same number of times. Launch the machine with the right hand grasping



both propellers, the left supporting the front of the machine, and be sure to launch on an even keel. For ease in launching it will be found best to place the screws to revolve outwardly, that is, the right-hand screw should be placed on the right-hand bearing (facing the line of flight), and the left-hand propeller on the left-hand bearing. Finally, keep the bearings well vaselined and the rubber lubricated, and apply the same methods of adjustment as advocated for the single screw monoplane.

By building and flying the simple machines herein described the young reader will probably be led to a deeper study of the subject, and so in his small way may conduce to the ultimate perfection of the science. There are many positions in the aeronautical industry waiting to be claimed by the diligent student—positions which no other industry can offer, for aviation is comparatively new to the world. These models can help you to such positions.



F. J. Camm,
Model Editor, "Aeronautics."

A "SKYSCRAPER" AMERICAN SEAPLANE, BUILT BY THE CURTISS COMPANY.

A BRITISH NAVAL AIRSHIP BOMBING A SUBMARINE.

[By courtesy of "Flying," U.S.A

AN OCEAN TO OCEAN AIR MAIL.

Air Services for Mails and Passengers

ALTHOUGH the War was to a large extent responsible for the rapid development of the aeroplane, and may thus be regarded as a cause of the position in which the industries dependent on flying now find themselves, it cannot be said that this development for war purposes has been an unmixed good. While the War lasted speed and climbing ability were the principal considerations in the minds of designers, and it was not until the Armistice was signed that the main consideration in any commercial plan, the cost of building and upkeep, came to be seriously considered. War gave opportunities for developing the speed and reliability of flying machines and dirigibles, but it is one thing to build a fast and safe machine when it does not matter how much the machine costs nor how much it costs to fly, and quite another to build a machine that shall be fast, be safe, carry the maximum of weight, and at the same time earn the cost of building and flying just as a railway engine earns the cost of building and running.

Even during the War several services were put into operation for peace uses, especially for mail-carrying, which served as experiments by which to estimate the cost of aerial journeys under peace conditions ; and it was found that, compared with rail and steamer services, flying worked out at a rather high rate per mile, mainly because the only machines obtainable for peace services were those which had originally been constructed with a view to war work—it was as if racing motor-cars were taken for omnibus work, or pleasure yachts or destroyers used for cargo carrying.

MAIL AIR SERVICES

One of the first services to be established was a French mail service in Northern Africa, linking up the coastal stations with the interior, and providing a regular and fast service over desert areas where no railway could be made to pay, even if one had existed, while intercourse by camel transport was irregular and unsafe. From the start this service was a success; being devoted to the carriage of mails, it was an urgent necessity, and since it was the principal and only certain means of getting communication, more especially for Government matters, it justified itself immediately. This may be considered the first regularly organized peace service, and, though little has so far been heard of it, it is one that will develop steadily as the aeroplane grows in carrying capacity and reliability.

Another early service was that between Northern Italy and Rome, the stations corresponding to railway termini in similar cases being Turin and Rome. This was established more as a matter of experiment than of direct use, though of course it was valuable as a mail-carrying service. Its principal use, however, was to show what observation of weather conditions was necessary, what the cost per journey came to, and how far such a service could be considered reliable in comparison with rail transport for the same type of goods. Austria started a similar service between Vienna, Lemberg, and Kieff in the later stages of the War, and in July, 1918, a second Austrian service was set going between Vienna and Budapest. Both these services, however, were mainly used for the transmission of military reports and urgent Government communications; they could not be reckoned as commercial undertakings. But they proved, by their continuous use, that even where railway services exist an aerial service is sometimes of such value that it is worth establishing one to compete with the railway. The Austrian military command utilized these air services to the fullest possible extent. The service between Vienna and Budapest was maintained once daily in both directions; an aeroplane left Vienna early in the morning, arriving at Budapest between seven and eight o'clock, the return journey being timed to begin between four and five in the afternoon, so that it was possible to send a letter and get a reply in the afternoon of the same day. The rail service made a reply a matter of three or four days, so in the case of urgent Government communications the value of such a service can be easily seen.

Shortly before the end of the War a third Austrian service was projected between Budapest and Odessa, by way of Arad and Kolosvar, but this did not materialize, owing to the unsettled condition of Hungary and southern Russia.

Germany, it seems, was too busy while the War lasted to organize any commercial or mail air services, though the German plans for aerial communication were very extensive and complete. The only trouble about them was that they were made on the assumption of German victory, and were more concerned with German penetration into other countries, and military control of other countries' air routes than with purely commercial intercourse.

Perhaps the most complete and efficient of the mail air services established during the War was the American postal service between New York, Philadelphia, and Washington, which was opened to public use in the middle of May, 1918. The original service was maintained by Curtiss biplanes, fitted with engines of 150 horse-power, and capable of carrying three hundred pounds weight of mail matter. Here the influence of War on construction showed plainly, for these were military machines provided by the American War Department, and they had to be adapted and modified before they could be used for mail transport purposes. The Curtiss Aeroplane Company, however, designed larger machines, capable of carrying double the load, for use as

[*Belgian Official.*

KING ALBERT OF BELGIUM ABOUT TO MAKE A FLIGHT ACROSS CHANNEL TO LONDON.

soon as War conditions relaxed and permitted building for peace use.

The service was so organized that one machine took the load from New York to Philadelphia, where a relay machine was waiting to carry on the journey to Washington. In case of engine failure or other trouble, four intermediate alighting stations were provided along the route. Letters, books, and parcels, each of which was limited to a total overall measurement of thirty inches (length and girth combined) were accepted for carriage by air mail, at first at a rate of about a shilling an ounce, and special stamps of this value were affixed. These stamps are already sought for by collectors just as eagerly as the very first postage stamps, and in a few years they will probably command as high prices as a triangular Cape or an early Mauritius.

This American service proved so popular, and the cost of maintaining it was so well controlled, that a few months after it was inaugurated it was possible to reduce the price per ounce to a little more than half the original rate. At the same time the running of the service was remarkably efficient, the machines flying to time and with almost perfect regularity from the start. In September, 1918, "100 per cent. efficiency" was achieved; throughout the month every machine flew to time, and in spite of adverse weather conditions on some days a perfect service was recorded at the end of the month.

In this direction, of course, lies the first development of aeronautics for peace purposes. Business mail traffic is the most important form of communication, and if time can be saved, as it undoubtedly can be by aerial postal routes, business men are quite willing to pay the extra cost involved, while the small bulk of postal matter as a rule renders a cargo of three hundred pounds weight fairly remunerative at a shilling an ounce—it works out at about £240 for the cargo, which pays for the journey and the cost of upkeep of the service.

In considering the establishment of a peace service on the ground of cost and the consequent charges that must be made, there are more things than the actual flying cost to be taken into account. There are terminal stations, with landing and starting grounds, to be laid out and kept up, with hangars for housing the planes, repair shops, and office accommodation; then there are not only pilots as staff, but mechanics and a clerical service to go on to the wages bill; there is a certain amount of printing and advertising to be taken into account, just as in the case of a railway or steamship company, and then there are the building and upkeep of machines and the training of pilots for the service. The item of machines is a big one, for even when a machine is built specially for commercial work it is not long-lived like a road motor, and after every journey requires overhauling by skilled mechanics and tuning up before starting out again. Thus it will be seen that the cost of flying—the petrol, the oil, and the pilot's salary—is but a small part of the cost of a regular service, and the charges made must be estimated with a view to paying eventually all the costs set out above, and showing a profit as well. And, because the aeroplane can carry only a small load when compared with road and rail and sea transport methods, it is not likely that travel by air will, for some years to come, be as cheap as other modes of transport. The services already described as in actual working, however, have proved that the aeroplane is the ideal mail carrier, and that as soon as the development of machines for peace uses has been thoroughly studied, such services can be made to pay at postage charges very little higher than the present postal rates for land transport.

Copyright] [*Western Newspaper Union.*

A FLYING BOAT THAT CARRIES FIFTY MEN.

This great Curtiss Flying Boat was originally built as a submarine chaser. She can carry six tons, with sufficient fuel for a thirteen-hour trip. The speed is 60 miles per hour, and it can climb 2,000 feet in 10 minutes

The main requirement of commercial services for many years to come will be improvement of the planes. Land and sea services have to face equal or greater costs in their establishment than those shown above; railways, in addition to stations, have to maintain their permanent ways and to keep staffs continually working on them. while the permanent way of the air needs neither rails nor ballasting material—only stations, terminal and intermediate, need be considered. At the present time, the number of mechanics required to keep an air service efficient is in excess of the number required by a rail or boat service of similar extent, but that is because, during the War, speed and climbing power were put before long service, and in design and construction the lasting qualities were not nearly so important as the maximum of power for a limited period. It was estimated that the actual flying "life" of a war machine, if it escaped accident, was two weeks—that is to say, the very limit of time it could spend in the air, apart from its time on the ground under overhaul and at rest, was fourteen days of twenty-four hours each. After that period, the machine was no longer fit for active service.

This, of course, will have to be improved on to a very great extent for peace service, and many aeroplanes have already exceeded it, for in War they were driven to the utmost limit of their capacity, while in peace they are driven at a fair working speed, and there is no need to strain them to the last ounce of power, nor to "do stunts," such as looping or spinning or tail-sliding, all of which involve extra strain on either fuselage or engine. But even when used at a fair rate of power the aeroplane of to-day is capable of much improvement in construction with a view to its having a longer flying "life." Experiments are being made with a view to sounder construction without increase of weight, and also with a view to the production of engines which will develop sufficient power to carry increased loads on the planes to which they are fitted without running the engines at such a rate as to render them unreliable after two hundred or three hundred hours of running. "Long life" for the machine and its engines is one of the principal problems to be solved in order to make commercial flying pay.

Another requirement is that of reducing the landing area necessary, for in the populated centres which air services would cater for buying ground for landing areas is a big item of cost, and also the smaller the area a plane can land in the nearer it can come to the centre of things. If, for instance, London aeroplane services could start from one of the Parks—Hyde Park or Regent's Park—much time would be saved in getting to or from the aero terminus to the places of business which might use the service. In the present state of development, it is necessary to make the terminal station as much as from five to ten miles from the centre of London, since the ground nearer in is so valuable that sufficient could not be acquired to make a landing and starting area. The matter of starting from a restricted area is in process of being settled by a sort of pneumatic carriage attached to a rail, by means of which the aeroplanes will be practically fired into the air by means of big cylinders of compressed air, when the pneumatic carriage will be drawn back along the rail to its starting place, ready to fire off another aeroplane.

But that does not solve the problem of alighting. As things are at present, allowing for every wind (since an aeroplane must always land with its head to the wind) an area of from ten to twenty acres is necessary for a landing-ground, and even that is small for weight-carrying planes. This is one of the big handicaps which science must remove, in all probability by altering and improving the design so as to give a much slower "landing speed" without altering the actual flying speed. Some of the later fast machines produced for War use, which had speeds of anything up to a hundred and eighty miles an hour, could not reduce their speeds below sixty miles an hour for landing, and it will be readily understood that an aeroplane hitting the earth at sixty miles an hour wants some space in which to pull up to a standstill. The solving of these problems is all part of the task of adapting the aeroplane to commercial uses, and it involves some fascinating work for the inventor and scientist, opening up entirely new fields of design and calculation.

For either mail or passenger services it has been ascertained that it is necessary to establish a number of intermediate stations along the route, as has been done in the case of the American postal service, since weather conditions may modify the distance that can be traversed without alighting. Under normal conditions, a weight-carrying aeroplane will accomplish its journey best in stages of about four hundred miles each; the famous trial flight to India in 1918 in a service Handley Page machine is a good example of how stages should be established.

In the case of this flight, depôts were established at points along the route, with petrol and oil supplies for the machine, and the journey was accomplished in seven stages. Starting from Cairo, the first run was to Damascus, a distance of 385 miles; the next flight was from Damascus across Asia Minor to Bagdad, and this, 523 miles, was the longest stage of the journey; the third stage took the machine on to Bussorah, on the Persian Gulf, a distance of 291 miles—both this and the next stage, to Bushire, were very short, the first being the longer, since from Bussorah to Bushire was only 224 miles; if the attempt to do both journeys in one, a total of just over five hundred miles, had been made, it would have been well within the capacity of the aeroplane, but the journey was taken in order to show the possibility of establishing a service which should be useful to all the principal centres of population on this route to India. The next stage was from Bushire to Bandar-Abbas, 397 miles; the next from Bandar-Abbas to Charbeh, 400 miles; and the last from Charbeh to Karachi, the great port of north-western India, a distance of 328 miles.

This may be reckoned as the first passenger flight undertaken for business purposes, for, although the passengers in the machine were on Government service, their business consisted in opening up and proving possible an air service from Egypt to India, with a view to establishing a regular service by this route. The flight proved the ease with which such a service could be maintained, and also proved its great value in connecting up the towns of the Persian Gulf with both East and West. Bagdad and Bussorah, now that Mesopotamia is removed from Turkish tyranny, are cities of great importance to the whole world, since they are centres for what can be made one of the best corn-growing districts of the earth, and an efficient air service, joining them to India and to Egypt, is certain to be of inestimable value.

In cases of this kind it is easier to establish a service by air than in any other way, if the climate is sufficiently free from fog, as it generally is in tropical and semi-tropical countries. If a railway were selected as the means of transport, it is slower in building, and far more costly than an air service; there are embankments and tunnels to be considered, and the cost of laying and keeping up a permanent way; while with an air service all that is needed is sufficient flat ground for starting and alighting, with hangars and supply stores at the stations—the initial cost is far less than for any kind of railway construction.

Similarly, if sea transport is considered, there is the provision of docks and wharves as well as that of the vessels, while here an air service has another advantage in that the machines can serve towns on the coast and towns of the interior as well, without any necessity for transhipment such as is involved by a combination of sea and rail transport; thus the air service saves time in more ways than one, both in setting up and in actual working.

The development, both of postal and passenger air services, is all in the direction of long-distance work. It is easy to understand why this should be, for the shorter the distance the easier it is for a railway or steamboat service to compete with the aeroplane in the matter of time. The rail journey from London to Glasgow, for instance, takes eight hours; the journey by air may be done in three hours, but to that must be added the time taken in getting from Euston, say, to the London air terminus, and the time taken in getting from the Glasgow air terminus to the centre of the city, where the railway runs in. Allowing an hour at each end for getting to the aerodrome, the total saving by air is only three hours.

On the other hand, the journey from London to Melbourne by air can be accomplished in a hundred flying hours, while the same journey by land and sea is at present at least a matter of a month. Allowing for all stoppages, and taking in the time for getting to and from the London and Melbourne termini, the total time is only eight days as against twenty-eight—a saving of a clear twenty days on the whole journey.

The amount of time saved in the London to Glasgow journey is less than half of that taken on the rail journey, while on the long-distance run to Melbourne nearly three-quarters of the far longer period is saved, and when the saving of time can be counted in days and weeks, instead of hours, it gives the aeroplane an advantage that will make air services useful to nearly every class of business, while as postal carriers for long distances there is nothing to compete with air lines.

The only drawback is that of small cargoes. Although the aeroplane will yet be improved to carry greater loads, it can never carry as much as steamship or train on the single journey, though, as methods of construction improve, it may be possible to run passenger services at only slighter greater cost per mile for each passenger than first-class railway or steamship fares.

The Language of the Air

AN aeroplane is almost invariably referred to by pilots as the "bus," the "machine," or the "tub," as fancy dictates.

The various types of aeroplanes are generally known by their makers' names, but there are others such as the "Camel," the "Rumpty," "the Snipe," the "Sopwith Pup" (a small Sopwith), the "Dolphin," the "Bloater," and the "Elephant." "B.E. 2 C." is short for "British Experimental Type, 2C."; and "SE. 5" is "Scouting Experimental Type, 5."

A triplane, such as that shown on our cover, is a "tripehound." "Tub" is the contemptuous appellation applied to a heavy, unwieldy machine.

Various parts of the craft are the "prop," propeller, or "wind-stick." The "joy-stick" works the principal controls, and is known technically as the "control lever." There are the "nose" and the "tail" of the machine, the wings, wing-tip (extreme point of the wing) fuselage (body), and the under-carriage (the framework beneath the body to support the craft on landing), with "floats" beneath seaplanes, for landing on the water.

"Blimps," "S.S.'s," and "Babies," are nicknames applied to the small types of British airships which were employed in scouting for enemy submarines. "C.P.'s" are coast patrol airships. The observation balloon labours under the unhappy sobriquets of "sausage" and "Randy Rupert," and, in the enemy's country, of "honeymoon."

The cadet adopting flying as a profession was at first known to the naval branch as a "quirk"; to the military branch as a "Hun." His preliminary training consisted of military drill, lectures on the theory of flight, and on engines. Later he was taken up as a "passenger" for a "joy-ride," and when sufficient air experience had been acquired was put on to "rolling," or "taxi-ing," across the surface of the aerodrome.

Stage by stage he graduated to "straights"—i.e. flying up and down, over, and well within reach of the landing-ground. Then would follow his "solo trip"; in plain English his first trip "upstairs"—in the air—alone.

Thence he progressed to "looping" (turning a somersault in mid-air), "banking" (to heel for the purpose of turning), and "gliding" (flying without the engine). Not until then did the pilot "get his wings up"—a much coveted emblem, worn on the left breast of the tunic, meaning that the wearer is a fully qualified airman. An observer wears a single wing.

Other terms much used are:—

"'Drome" or "landing ground": the aerodrome.

"Hangar": an aeroplane shed.

"Stall," To: to lose way in the air.

"Bank," To: to heel for the purpose of turning.

"Stunt," A: a bombing raid, patrol, or similar flight.

"Wind-screen" before the pilot's seat, screens the wind from his face.

"Fan down" To: to blow up by means of bombs.

"Side-slip," A: when the machine slips out through over-banking.

"Forced landing": an unintentional landing, due to engine failure, "Archie," or otherwise.

"Archie": enemy anti-aircraft shell.

"Rev": revolution of the engine.

"Revmeter": an instrument for indicating number of revolutions.

"Eights": flying first to the left, then to the right, as the figure 8.

"Drum": a tray of machine-gun ammunition.

"H.E": high explosive.

"H.A.": hostile aircraft.

"Following wind": a wind behind the machine.

"Head wind": a wind blowing against the machine.

"Crash": a bad smash up; usually follows a "Spinning nose-dive"; for which the official guide-book cautions: "Centralize all controls, and push the stick forward."

In the flying phraseology of our Allies in France the term "ace" signified a pilot who had brought down five or more enemy machines.

The enemy had also an extensive flying vocabulary, among the more general terms being "seesaw" for an aeroplane, "stable" for hangar, "Emil" for a pilot. An inefficient pilot was a "shipwrecker." To fly in bad weather is to fly "in bottle weather." A "windy corner" is a danger zone; bringing an enemy pilot down is to "give him something sour," while to be brought down oneself is to "get something sour."

EDGAR C. MIDDLETON.

[*British Official.*

COAST DEFENCE.

The car of a Naval Airship, which is about to ascend.

Some Notable Records in Aviation

WHEN, on December 17, 1903, Wilbur and Orville Wright actually flew with a power-driven aeroplane, they undoubtedly did the greatest thing that had ever been accomplished in flight, a thing, as we have shown elsewhere, other men had vainly attempted for centuries. That first flight lasted for just twelve seconds; four trials in all were made that day, and the fourth flight was a matter of only 59 seconds.

It was not until September 26, 1905, that another record was established by the Wright brothers, Wilbur remaining in the air for eighteen minutes, a wonderful achievement for those days. The next record of any account also came to one of the Wrights, for on September 9, 1908, Orville made the first flight of over an hour's duration.

From then onward the records began to grow. Henry Farman put up the first cross-country record with a flight of 17 miles from Bouy to Rheims, on October 30, 1908, and on the last day of that year Wilbur Wright regained the honours with a flight of 2 hours 20 minutes at Auvours, France. Although successful flying was born in America, the honour of its early development belongs principally to France, where the Wright brothers migrated owing to the greater general interest in aviation displayed in that country.

In the next year, 1909, the great event was Blériot's Cross-Channel flight on Sunday, July 25. Starting immediately after sunrise, in fifty minutes he saw Deal through the haze. Then he flew toward Dover and landed there, observed only by a French journalist.

Less than a year later C. S. Rolls flew from Dover to Calais and back; but those were days of lightning-like progress in aviation. A little earlier, on April 28, 1910, Louis Paulhan had flown from London to Manchester with only one stop. In September, 1910, Georges Chaves, a Peruvian, made a gallant and successful flight across the Alps, only to injure himself so seriously in the descent that he died a few days later. Five days after Chaves's flight Maurice Tabuteau, a Frenchman, succeeded in flying across the Pyrenees.

A few records remain to be established. The man who first crosses the Atlantic in an aeroplane will rank with Blériot; but by the time a man appears who will fly round the world without alighting, the aeroplane will be such a commercial and everyday thing that in all probability the record will scarcely be noticed. Duration of flight and distance covered are matters more of machine than of man, and in all likelihood the records of the future that will be most sought after will be those of altitude, since these call for the limit of human skill and endurance.

The following is a list of the principal established flying records from the earliest times up to the interruption of record-making by the War. Most of the records established during the War—they were very many—had, for obvious reasons, to remain unpublished, and are only now becoming known.

A.D. 1065. Oliver of Malmesbury, attempting flight with artificial wings, injured himself in jumping from a tower.

1678. Besnier, a French locksmith, made a series of gliding flights with a wing apparatus rather similar to that used later by Lilienthal.

1782. The brothers Stephen and Joseph Mongolfier invented the hot air balloon.

1783. November. The first balloon flight by man was made by Pilâtre de Rozier and the Marquis d'Arlandes, who made a balloon ascent and were carried over Paris, alighting safely at the end of their adventure.

1784. The Brothers Robert (French) attempted to propel a balloon in the air by means of oars, the first attempt at navigating a balloon in the air.

1794. A military balloon section was formed in the French Republican army, and balloons were employed in war for the first time at the Battle of Maubeuge.

1848. John Stringfellow constructed the first power-driven model aeroplane that achieved flight.

1852. Giffard's airship, the first successful dirigible balloon, constructed.

SOME NOTABLE RECORDS

1888. Fernand Forrest, a Frenchman, designed and made the first internal combustion motor-engine.

1896. Otto Lilienthal (German) killed on August 10, after nearly ten years of gliding experiments, which contributed materially to the development of flying machines.

1897. Clément Ader claimed to have made the first power-driven aeroplane flight at Satory, France, a claim which has been so disputed that it is generally ignored in the history of flight.

1899. September 30. Percy Pilcher killed while making gliding experiments at Market Harborough.

1900. Wilbur and Orville Wright took up gliding, making many experiments at Kitty Hawk, North Carolina.

1903. Voisin and Blériot experimented in attempts to produce a power-driven aeroplane.

1903. On December 17 Wilbur and Orville Wright made the first flights in a power-driven aeroplane, the flights ranging from 12 seconds to 59 seconds in duration.

1905. On September 26 Wilbur Wright, on a Wright biplane, made a flight of 18 minutes.

1906. On August 22nd. Santos-Dumont made a short aeroplane flight at Bagatelle, France.

1908. Jan. 13th. Henry Farman won a prize for circular flight.

Sept. 9th. Orville Wright remained in the air on a Wright biplane for over an hour.

Dec. 31st. Wilbur Wright, flying at Auvours, France, remained in the air for 2 hours 20 minutes.

1909. June. First aviation meeting held at Rheims—over a hundred flights made by various aviators.

July 25th. Blériot flew across the Channel from Barraques, near Calais, landing at Dover.

Nov. 3rd. Henry Farman flew for 4 hours 6 minutes at Mourmelon, covering a distance of 144 miles.

1910. April 28th. Louis Paulhan flew from London to Manchester, 183 miles, with one stop on the journey.

June 2nd. C. S. Rolls flew across the Channel from Dover to Calais, and back.

Sept. 23rd. Georges Chaves flew across the Alps, but sustained such injuries in landing that he died four days after.

Sept. 28th. Maurice Tabuteau flew across the Pyrenees.

Dec. 18th. Henry Farman made a flight of 282 miles in 8 hours 12 minutes.

Dec. 30th. Tabuteau flew 365 miles in 7 hours 48 minutes.

1911. Jan. 17th. E. B. Ely, American, flew from the shore at San Francisco to the U.S. cruiser Pennsylvania, landing on the cruiser, and flew back to land.

May. J. Vedrines won the Paris-Madrid race, 732 miles, flying a Morane biplane.

May. Beaumont won the Paris-Rome race, 916 miles, flying a Blériot monoplane.

June 27th. Beachey (American) crossed Niagara falls on a Curtiss biplane, and flew under the arch of the steel bridge across the Falls.

July. Koenig (German) won the German national circuit race, of 1168 miles, flying an Albatros biplane.

July. Beaumont won the Paris-Brussels-London-Paris circuit of 1080 miles, on a Blériot monoplane.

July. Beaumont won the circuit of Britain race, 1010 miles, on a Blériot monoplane.

Sept. 9th. Aerial post from Hendon to Windsor tried as an experiment in sending mails by aeroplane.

September. Trans-American competition, 2600 miles, run off. One competitor, C. P. Rogers, completed the distance, but failed to comply with the time limit.

Nov. 28th. H. Salmet, at Hendon, reached a height of 8070 feet.

1912. Sept. 9th. A speed of 105 miles an hour, average speed of flight, accomplished at Chicago, by Vedrines, on a Deperdussin monoplane.

Aug. 12th. G. de Havilland, with passenger, reached a height of 10,560 feet on a B.E. biplane with 70 h.p. Renault engine, at Salisbury Plain.

1913. May 31st. H. G. Hawker, at Brooklands, reached a height of 11,450 feet, flying a Sopwith biplane, with 80 h.p. Gnome engine.

June 16th. H. G. Hawker, with passenger, reached a height of 12,900 feet, flying a Sopwith biplane, with 80 h.p. Gnome engine.

[E. N. A.

A HISTORIC FLIGHT.

Orville Wright making the world's first hour-flight at Fort Myer, Virginia (September 9, 1908).

Oct. 2nd. Louis Noel, flying a Grahame-White biplane with 120 h.p. Austro-Daimler engine, made a flight of 19 minutes 47 seconds, carrying nine passengers.

Dec. 28th. G. Legagneaux, flying in France with a Nieuport monoplane, reached a height of 6,120 metres (over 20,070 feet).

1915. June 6th. H. G. Hawker, flying a Sopwith biplane with 80 h.p. Gnome engine at Hendon, reached a height of 18,393 feet.

1916. April 26th. H. G. Hawker, flying a Sopwith biplane at Brooklands, reached a height of 23,904 feet.

1917. July. A large Handley Page bombing aeroplane flew from England to a Mediterranean base, subsequently bombing Constantinople. The total distance flown was nearly 2,000 miles, the machine being in the air over 31 hours and carrying a total load of about six tons.

August. Captain Laureati, of the Italian Air Service, made a non-stop flight with a passenger from Turin to Naples and back (950 miles) in 10 hours 10 minutes.

September. Captain Laureati, with a passenger and two machine-guns, flew from Turin to London (656½ miles) in 7 hours 22 minutes, the first direct flight between the two countries.

Oct. 22nd. Lieut. Resnabi, flying a Caproni machine, covered a distance of 300 miles (from Newport News to Mineola Camp, U.S.A.) in 4 hours 15 minutes, carrying 8 passengers and flying at a height of 4,500 feet.

1918. Sept. 18th. Capt. R. W. Schroeder, flying at Fairfield, Ohio, in a Bristol fighting biplane with a 300 h.p. Hispano-Suiza engine, made a world's height record of 28,900 feet.

Nov. 15th. A Handley Page four-engined machine, piloted by Mr. Clifford B. Prodger, flew over London at a height of 6,500 feet, carrying forty passengers.

Nov. 27th. A Curtiss N.C. 1 seaplane, fitted with three Liberty engines of 385 h.p. each, piloted by Lieut. E. H. McCollough, U.S. Naval Reserve Flying Corps, made a flight at Rockaway, N.Y., with 50 passengers on board. Speed of flight, 72 miles per hour.

Dec. 12th. Completion of the Cairo-Delhi flight by Major-General W. G. H. Salmond, D.S.O., accompanied by four other persons, in a Handley Page machine. The machine left Cairo on November 30th, and accomplished the journey in seven stages, with a total of a little over 57 hours in the air.

1919. Jan. 2nd. Flying at Martlesham, near Ipswich, Captain Andrew Lang captured the world's altitude record by climbing to 30,500 feet in 66 minutes 15 seconds on a D.H. 9 two-seater machine fitted with 450 h.p. Napier "Lion" engine.

May 17th–18th. The United States seaplane N.C. 4, with Liberty engines, piloted by Lt.-Commander Read, flew from Trépassey, Newfoundland, to the Azores, 1,381 miles, in 15 hours 18 minutes. On the 27th, ten days later, the flight was resumed to Lisbon, another 900 miles, thus completing the first Transatlantic flight. On May 31st the trip was continued to Plymouth, 840 miles.

May 18th–19th. Mr. Harry G. Hawker, with Commander Mackenzie Grieve, R.N., as navigator, attempted the first non-stop flight of the Atlantic. Leaving St. John's, Newfoundland, on a Sopwith biplane with Rolls-Royce engine, at 6.48 p.m., they flew for 14½ hours, being obliged by a mechanical trouble to descend when about 750 miles from the west coast of Ireland. The aviators were rescued by the Danish steamer *Mary*, but for nearly a week the world was in suspense as to their fate.

June 14th–15th. *First Direct Atlantic Flight.* Captain J. Alcock, D.S.C., with Lieut. Arthur Whitten Brown as navigator (both afterwards knighted), made the first direct flight across the Atlantic, winning this greatly coveted record for Great Britain. The flight was made on a Vickers-Vimy machine with two Rolls-Royce engines of 375 h.p. each. The distance from St. John's, Newfoundland, to Clifden, Galway, 1,950 miles, was covered in 16 hours 12 minutes, an average speed of about 120 miles per hour.

July 2nd–13th. *First Return Atlantic Crossing.* The British airship R 34 left Temple Fortune, Scotland, at 1.42 p.m., on July 2nd, and reached Mineola Aerodrome, Long Island, New York, at 10 a.m. on July 6th. Returning, she left Long Island at 11.54 p.m. on the 9th, and reached Pulham, Norfolk, at 6.56 a.m. on July 13th, having accomplished the return journey in 75 hours 3 minutes.

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